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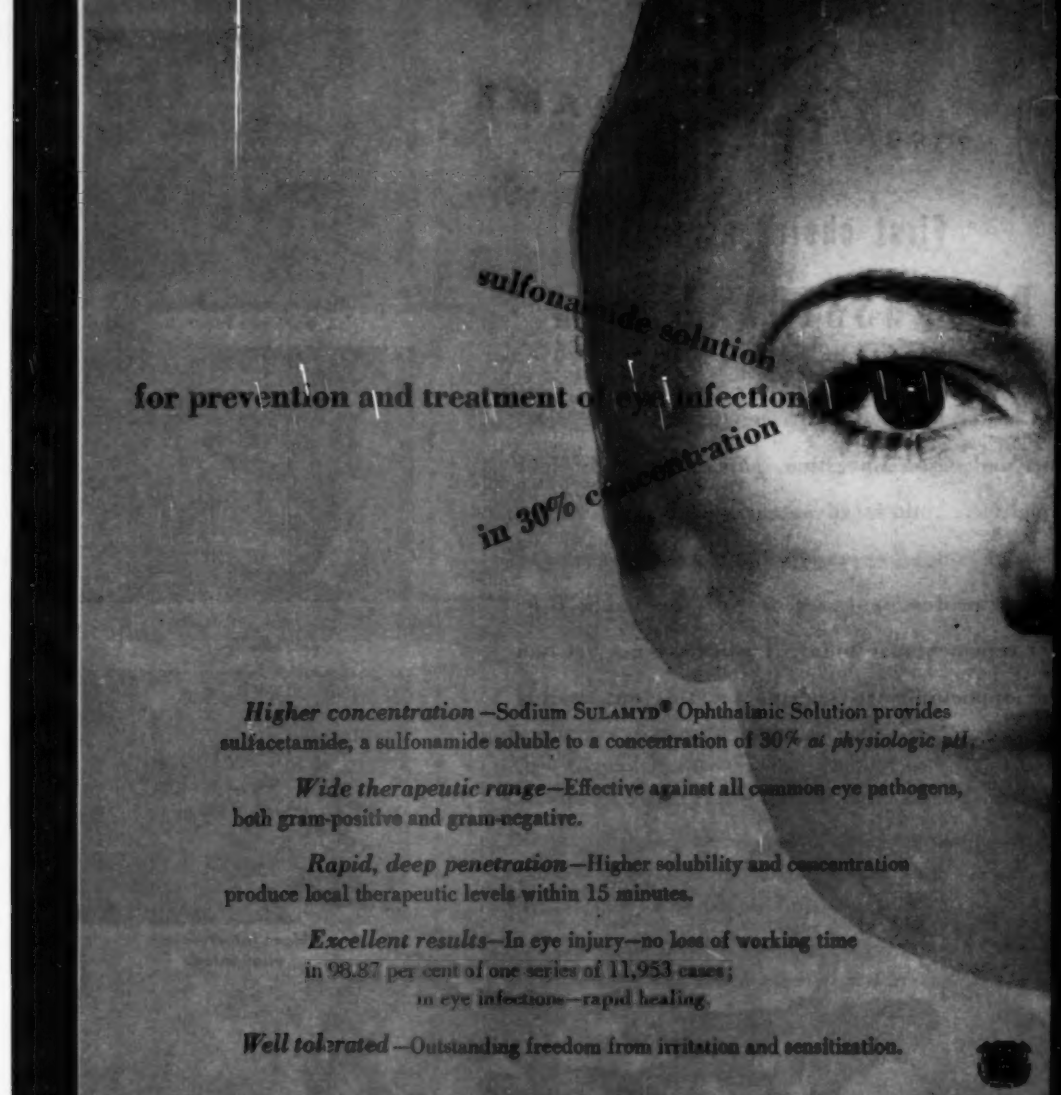

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PRISMATIC EFFECT OF OBLIQUE CYLINDERS

Space does not permit us to discuss the revised oblique axis cylinder chart presented below. In the June "scientific corner," examples of its use will be given as well as cases showing the errors inherent in the previous charts.

RIGHT EYE			LEFT EYE		
AXIS	VERT.	HOR.	VERT.	HOR.	AXIS
90	000	.20 out	000	.20 out	90
85	.02	.28 out	.01	.13 out	85
80	.06	.34 out	.01	.06 out	80
75	.11	.40 out	000	000	75
70	.16	.44 out	.02	.07 in	70
65	.22	.48 out	.06	.13 in	65
60	.29	.50 out	.11	.18 in	60
55	.36	.52 out	.16	.23 in	55
50	.43	.52 out	.22	.27 in	50
45	.50	.50 out	.29	.29 in	45
40	.57	.48 out	.36	.30 in	40
35	.63	.44 out	.43	.30 in	35
30	.69	.40 out	.50	.27 in	30
25	.74	.34 out	.57	.27 in	25
20	.77	.28 out	.63	.23 in	20
15	.80	.26 out	.69	.18 in	15
10	.81	.14 out	.74	.13 in	10
5	.81	.07 out	.77	.07 in	5
180	.80	000	.80	000	180
175	.77	.07 in	.81	.07 out	175
170	.74	.13 in	.81	.14 out	170
165	.69	.19 in	.80	.26 out	165
160	.63	.23 in	.77	.28 out	160
155	.57	.27 in	.74	.34 out	155
150	.50	.27 in	.69	.40 out	150
145	.43	.30 in	.63	.44 out	145
140	.36	.30 in	.57	.48 out	140
135	.29	.29 in	.50	.50 out	135
130	.22	.27 in	.43	.52 out	130
125	.16	.23 in	.36	.52 out	125
120	.11	.18 in	.29	.50 out	120
115	.06	.13 in	.22	.48 out	115
110	.02	.07 in	.16	.44 out	110
105	000	000	.11	.40 out	105
100	.01	.06 out	.06	.34 out	100
95	.01	.13 out	.02	.28 out	95
90	000	.20 out	000	.20 out	90

Calculated for + 1.00 D cylinder. All vertical figures are base up Horizontal as marked. In using this chart, transpose all cylinders to plus.

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AMERICAN JOURNAL OF OPHTHALMOLOGY

VOLUME 35 APRIL, 1952 NUMBER 4

SURGICAL TREATMENT OF CONGENITAL GLAUCOMA*

A NEW CONTACT LENS FOR GONIOTOMY

MANUEL URIBE TRONCOSO, M.D.
New York

In 1942 Otto Barkan[1-5] published an account of 17 successful operations for congenital glaucoma by the method of goniotomy or incision of the angle of the anterior chamber. The results in all these cases were very encouraging. Pressure was normalized in 16 of the 17 eyes and vision was maintained in 14. All cases were those of children with an average age of three months at the time of the operation (from eight days to two years). The good results were maintained from one to five years in these cases.

As all previous experience with other methods in the surgical treatment of hydrophthalmia had been short of disastrous, Dr. Barkan's communication was received with great interest and attention.

His results were confirmed by several authors: Allen,[6] Rocha,[7] Scheie,[8] McKinney,[9] Kluyskens,[10] McArevey,[11] and others.

MECHANISM OF HYPERTENSION IN HYDROPHTHALMIA

Since the pathologic examination of eyes affected with this disease made by Horner (1880) and later by Cross (1896), Seefelder (1906), and others, it has been established that the angle of the anterior chamber is obstructed by mesodermal tissues which failed to be absorbed at the proper time before the birth of the child. The presence of Schlemm's canal has been variously described as existing behind the obstruction or being entirely absent (Cross, 1896). It has been ascertained, however, that Schlemm's canal is present in the earlier stages of the disease in about 75 percent of the cases (Anderson[12]). Later it becomes clogged or displaced and disappears in more than half of the specimens taken from children over two and one-half years of age.

Anderson thinks that Schlemm's canal closes in later stages due to the distention of the eyeball by the increased intraocular pressure. When this occurs, the eye is permanently damaged and no operative treatment can restore the normal level of the intraocular pressure. Barkan insists on the necessity of performing the operation immediately after the first signs of hydrophthalmia are discovered.

The good results obtained by this author undoubtedly can be ascribed to the section or rupture of the mesoblastic tissues filling the angle and covering Schlemm's canal, and the reëstablishment of aqueous filtration through the trabeculum uncovered by the operation.

According to Barkan, goniotomy, when performed early, has these advantages: (1) Of immediately reducing the intraocular pressure; (2) reducing the size of the eyeball before the distention produces permanent pathologic changes and obstruction of Schlemm's canal; (3) restoration of vision and avoiding of blindness.

* From the Department of Ophthalmology, College of Physicians and Surgeons, Columbia University, and the Institute of Ophthalmology of the Presbyterian Hospital.

Before the advent of the gonioscope only pathologic specimens of hydrophthalmic eyes could detect the presence of mesoblastic tissue and establish the obstruction of the angle. Later, gonioscopy, by direct examination of the angle, showed conclusively the extent and character of the embryonic tissues covering the angle and the changes produced in its normal appearance.*

With this method Troncoso,[13] Sugar,[14] and other observers found that the iris root appeared to have been drawn up and was inserted more or less higher, nearer the Schwalbe line at the end of the Descemet's membrane. The normal sinus of the angle had entirely disappeared. An attentive observation in the early stages shows that there are numerous fibers of an abnormal meshwork tissue which cover the trabeculum and change to a slanting wall the normal sinus of the angle. Sugar found the iris tissue relatively transparent as he could see through it the reflection of the pigment epithelium from the ciliary body to the iris.

Although mesoblastic tissue in the angle is pigmented and resembles, in places, a normal rarefied iris, it is important to understand that the root of the iris has remained in place and that the persistent meshwork fills the space between the iris and the scleral wall.

That this is the case is proven, besides, by the results of goniotomy operations. When the aberrant meshwork is sectioned there is no hemorrhage but, if the iris tissue below is cut out, a large hemorrhage usually ensues, both from the iris vessels and, in some cases, from new vessels which are commonly present at the surface of the membrane.

Goniotomy operation

De Vincentis, in 1892, described, with the name of "incision of the angle of the anterior chamber," an operation consisting of the section by a narrow knife of the tissues beyond the iris root and over the scleral wall. He thought this incision opened Schlemm's canal, and reëstablished the outlets from the angle in cases of primary glaucoma.

Otto Barkan, in 1936, revived this operation and greatly improved its technique by performing the section not in a blind way as De Vincentis had done, but under direct gonioscopic observation through a special contact glass which he devised.

This contact glass had a flat shape and permitted examination of the angle through a binocular loupe worn by the surgeon, which magnified the images from four to five times.

Barkan also claimed that it was possible to direct the point of the knife to Schlemm's canal and open it into the anterior chamber to relieve hypertension and reëstablish the aqueous outflow. Later he used goniotomy for operations on hydrophthalmic eyes.

Unfortunately, this contact lens did not stand up to expectations as immediately the surgeon raised it on one side to introduce the knife into the cornea, the liquid under the glass flowed out and air bubbles penetrated, obliterating the angle image. Besides, the presence of the glass prevents a good fixation of the eyeball by the surgeon, inasmuch as the glass conceals the limbus on the opposite side from where the knife is introduced.

To avoid this difficulty, Barkan advises the fixation of the globe with two forceps held by an assistant, above and below the globe, while the surgeon punctures the cornea. Barkan, and others, have lately discarded this contact glass for the operation and advises performing goniotomy in a blind way, keeping the knife parallel to the iris surface. Barkan also discontinued the operation for primary glaucoma, confining it to cases of hydrophthalmus in which, as mentioned before, it has produced excellent results.

Ellis[15] has modified Barkan's lens, reducing its size and changing its form to an egg-

* With the slitlamp microscope, Juler was also able to see the meshwork stretching from the angle and back of the cornea to the iris and pointed to the deficiency of the iris stroma at the corresponding sector.

shaped area. He cuts the edges of this area vertically down so that the glass is applied higher upon the corneal surface, leaving, on either side, an uncovered space through which the knife can be inserted into the cornea. The glass is provided with a central rod which the surgeon presses down upon the globe to insure stability.

Later Ellis tried to obliterate entirely the span between glass and cornea, the "water chamber," as he calls it, which he did not find necessary for clearness or magnification of the image. In this way the contact lens lays directly over the surface of the cornea which has been flooded with saline solution. In Ellis's three cases there were never "abrasions or cloudiness of the cornea," but he mentions that some striations appeared over the membrane, induced by the flat curvature of the glass. The reduced size of the glass allows only the examination of one third or one fourth of the angle circumference.

Ellis describes three cases of goniotomy in two of which hemorrhages were produced in the anterior chamber during the operation. This glass also has the disadvantage that an assistant is necessary to fix the eyeball with forceps during the intervention.

Mesorrhexis

In order to avoid the risk of wounding the iris and producing a large hemorrhage, several surgeons, instead of cutting the mesoblastic tissues with a knife, have tried to tear out the insertion of the meshwork from the scleral wall with a spatula introduced into the chamber, with which the iris is forcibly depressed downward. Good results have been reported with this method in early cases of hydrophthalmia.

Air injection

In 1945, Hughes and Cole advised filling the anterior chamber with air after withdrawing the aqueous, thus permitting observation of the angle without using a contact glass in operations for hydrophthalmia. They devised a new knife to which two syringes were connected—one for withdrawing the aqueous and the other for injecting air. This method has not been used extensively, as the image of the angle from an air-filled chamber is not very clear. Besides, the technique is not easy and the operation may be dangerous since, in some cases, the air injection has induced a certain amount of hypertension.

Surgical contact glass

To avoid the uncertainty and danger of making a blind incision of the tissues of the angle, I have devised a new contact glass which permits the introduction of the knife into the anterior chamber without disturbing the lens fluid, and with which the image of the angle, all around, is kept clear throughout the whole operation. This new glass has the advantage, too, of permitting the surgeon to fix the eyeball by himself, with forceps, grasping the limbus at the opposite side of the corneal puncture.

The surgical contact glass is the same goniolens (both the old and the tubular models) used for gonioscopic examination on which two windows have been made in the glass on opposite sides and reaching the edge of the glass (fig. 1-A and B, m and m′).

These windows are of different sizes and are covered with a rubberlike plastic material. Through the smaller, round window (fig. 1-m) the knife can be introduced easily into the anterior chamber, perforating the membrane, and then puncturing the cornea. There is not any loss of fluid and no air bubbles can be introduced. The tip of the knife is seen perfectly and may be followed through the glass to any part of the angle which has to be sectioned. The membrane is elastic and after the knife is withdrawn it seals by itself.

The larger and narrower window on the opposite side of the glass is also covered with a membrane (fig. 1-m′). This can be pushed

inward by the tip of the forceps to permit a good hold on the globe by the surgeon manipulating the instrument himself (fig. 1-B, Fx).

There are two kinds of surgical goniolenses, the tubular and the ordinary diagnostic goniolens. For the tubular model (fig. 1-A and B), the tube has been displaced backward over the convex surface so as to give the observer a larger field of the opposite side of the angle. In the ordinary goniolens (fig. 2-C and D), the tube is missing, but the two windows on either side are covered with the same rubberlike elastic membrane. This glass is more difficult to apply but once in place, after removing the air bubbles, it stays over the cornea better on account of the negative pressure it develops.*

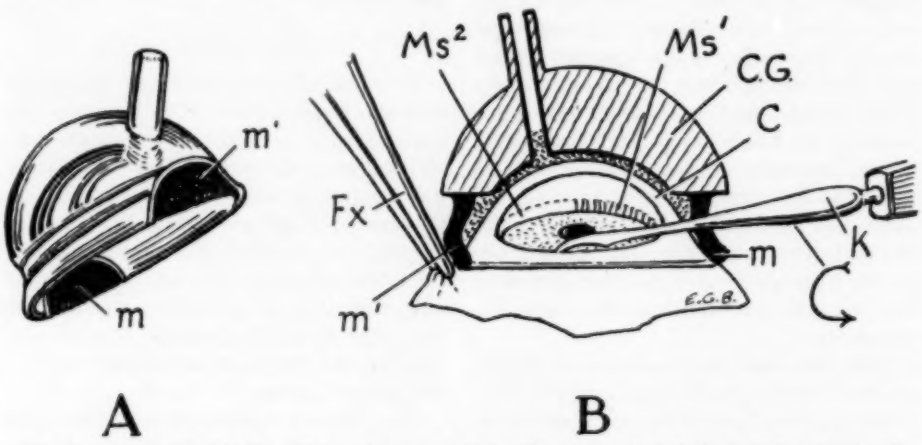

Fig. 1 (Troncoso). (A) Surgical goniolens provided with a tube which is inserted laterally to give a larger view of the angle. The two windows (m and m') on the opposite sides of the glass are covered with rubberlike membranes. (B) Schematic section showing the contact glass (C.G.) in place on the eye for operation. The knife-needle (K) has penetrated through the membrane (m) and the cornea (C) and divided the mesoblastic tissue (Ms^2) leaving the angle free at (Ms'). The curved arrow shows the direction of the knife movement. On the opposite side of the angle the fixation forceps (Fx) pushes the membrane inward and grasps the conjunctiva at the limbus to steady the eyeball.

Technique of goniotomy with contact lens

The operation should be performed under general anesthesia in small children since its execution demands complete immobility of the eyeball. After instilling a few drops of cocaine, the surgical contact lens, previously washed with an antiseptic, cleaned with a wetting agent (zephiran, 1:1,000), and finally rinsed in sterile water, is placed over the eye.

In the tubular model, the cavity is filled through the tube with sterile water until all the air bubbles are expelled. The knife needle should have a sickle shape (preferably, Ziegler's knife model) and its shank should be progressively thicker so as to obliterate completely the corneal wound.

The small window of the glass should be turned toward the temporal side of the eye. It is advisable that at least two thirds of the circumference of the chamber should be sectioned. However, the glass can be rotated so that the window faces any other side of the limbus when the surgeon wants to make the section in any other direction of the angle.

With his left hand holding the fixation

* The surgical goniolens is made by A. Oriani, 17 South Grove Street, Freeport, L.I., New York.

forceps, the surgeon depresses the membrane and grasps the corneal limbus. Before the puncture is made, an assistant should press the tube of the glass downward to prevent its displacement with the forceps. He should also see that the tube is filled with additional water if any bubbles tend to penetrate into the glass.

The older goniolens, without the tube, also provided with two windows and membranes (fig. 2), may also be used to advantage, inasmuch as it has a strong negative pressure which helps to keep the glass over the globe during the operation and does not have to be pressed down by an assistant.

Through the contact lens, the angle is illuminated by the strong light of an electric torch and the surgeon, using a binocular loupe, examines the angle all around to determine the position of the Schwalbe line which is the anterior border line of the angle. This line is sometimes pigmented and easy to recognize, but other times it is marked only by the difference in color between the mesodermic tissues and the cornea.

The tip of the knife, after perforating the membrane and the cornea, should be pushed straight, keeping it parallel to the iris surface. When it reaches the angle, the tip is directed into the aberrant meshwork which is punctured and then cut out to the desired extent around the circumference of the limbus, using semicircular movements of the handle (fig. 1-B). The section should be made about one mm. below the Schwalbe line, always avoiding directing the point downward toward the iris.

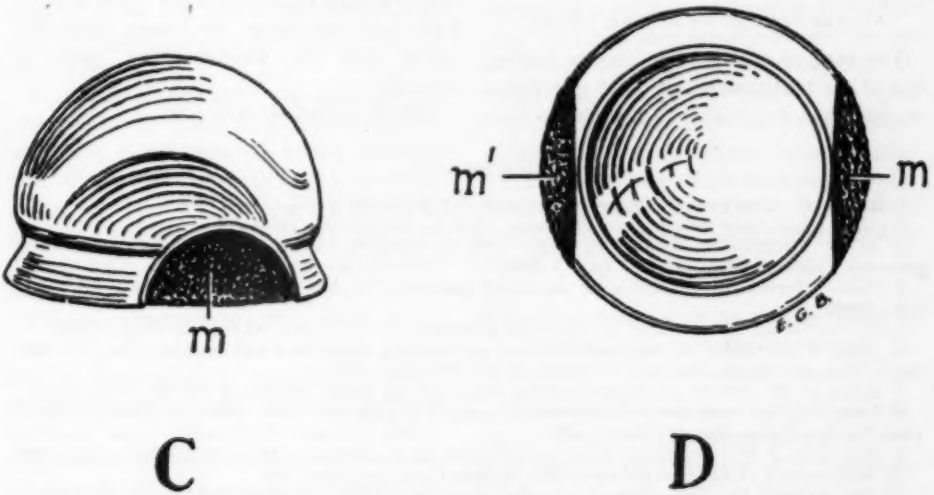

Fig. 2 (Troncoso). (C) Surgical goniolens without tube, provided with two windows which are covered with rubberlike membranes. (D) Frontal aspect showing the two membranes filling the apertures on the opposite sides of the contact glass.

Mesorrhexis

When the observer finds, through gonioscopic examination, that several new vessels have developed in the iris surface near the angle, it seems advisable to avoid the risk of hemorrhage by tearing down the aberrant mesoblastic tissue instead of dividing it with the knife.

The operation is conducted as described before but, when the knife needle reaches the angle, it is turned around and the blunt side of the edge is applied and pressed down forcibly, scraping down the whole mesoblast. This usually gives way and is torn down

from its insertion to the inner sclera.

Relapses

Sometimes goniotomy fails the first time and the intraocular pressure remains high. In these cases a second or third operation should be performed at convenient time-intervals, until the permanent reduction of hypertension is obtained.

Other operations in the angle

The surgical contact glass may be applied also to the performance of other operations on the angle in addition to goniotomy. The operation described by Scheie, which consists of dividing the limbus immediately above the Schwalbe line from the inside to the outside, could be more easily performed with the contact lens than in a blind way as it is done now.

I think that, in the future, other operations, such as reverse cyclodialysis, could be performed from inside, cutting the scleral spur through the ciliary-body band with a knife and separating the tissues from the sclera until the suprachoroidal space is reached.

500 West End Avenue (24).

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Ophthalmic Miniature

The disease termed glaucoma consists essentially in an alteration of the component parts of the vitreous humor, accompanied by derangement of structure of the hyaloid membrane, of the retina, and tunica choroidea, the vessels of which are always more or less in a varicose state.

Guthrie, *Lecture on the Operative Surgery of the Eye*, 1830.

THE NEUROVASCULAR MECHANISM AND THE CONTROL OF INTRAOCULAR PRESSURE*

ERNST SCHMERL, M.D.† AND BERNHARD STEINBERG, M.D.
Toledo, Ohio

Glaucoma is one of the more vexatious conditions which puzzles and plagues the ophthalmologist. The causes of the primary type especially have been disturbing. This paper represents one of a series of investigations of the role played by the neurovascular mechanism in the development of primary glaucoma.

In previous articles[1,2] we described the presence in the spinal fluid of two pituitary principles which affected ocular pressure. One of the principles, labeled by us hyperpiesin, increased the pressure and the other, miopiesin, decreased it.[2] These two substances were assumed to be in equilibrium under normal conditions.

Certain exaggerated physiologic states, however, were found to influence the formation of these pituitary principles. Exposure of man to strong light and of rabbits to darkness over prolonged periods was associated with excessive production of miopiesin. On the other hand, exposure of man to darkness and of rabbits to light resulted in an increased secretion of hyperpiesin.[1,3]

This paper concerns itself with the effect of certain physiologic stimuli upon intraocular pressure and the neurovascular mechanism. Our working hypothesis assumes the presence of a diencephalic center or centers which may be acted upon by several different stimuli including the pituitary principles. Magitot,[4] on the basis of his investigations, also postulated a regulating center located in the diencephalon.

These centers are assumed to mediate impulses originated by the pituitary principles. The impulses are carried along the sympathetic and the parasympathetic pathways.

Hyperpiesin, by acting on the parasympathetic center, produces dilatation of ocular vessels and a consequent increase of intraocular pressure. Miopiesin, on the other hand, exerts its action on the sympathetic center with a resulting contraction of the vascular bed and a decrease of pressure. An excellent and complete summary of these investigations and the mechanism has been given by Scheie in his review on glaucoma.[5]

The following experiments were designed to evaluate the role which the neurovascular mechanism plays in relation to external stimuli applied to the eye and other sensory organs.

EFFECT OF ODORS ON INTRAOCULAR PRESSURE AND RELATION TO NEUROVASCULAR MECHANISM

The sense of smell was tested in its relation to ocular tension. Some neurophysiologists maintain the existence of an interrelationship among the various sensory organs. There is a tendency on the part of these workers to classify sensory stimuli as either "dark" or "bright."[6-9] The results obtained from two odor-containing substances are presented. One of them, benzene, represents a "dark" stimulus. The other, left-citronellol, is an example of a so-called "light" stimulus.

Rabbits were used as experimental animals. Ocular tension was determined by the Schiøtz tonometer. The recorded readings were in terms of the third corrected curve of Schiøtz. The eyes were anesthetized with one drop of one-percent butyn. Tension was obtained with two weights, the 5.5 gm. and the 10 gm.

Only those animals were used which were placid. The rabbits were handled repeatedly by the same investigator prior to the onset of the experiments. Selection of proper animals and the obtaining of their confidence

* From The Toledo Hospital Institute of Medical Research. This work was supported by a grant from the Snyder Ophthalmic Foundation.

† Research ophthalmologist of the Snyder Ophthalmic Foundation.

TABLE 1

EFFECT OF ODORS ON INTRAOCULAR PRESSURE OF RABBITS
(Schiøtz tonometric readings expressed in mm. Hg)

Exposure to Odor of Benzene				Exposure to Odor of Left-Citronellol			
Before Exposure		After Exposure		Before Exposure		After Exposure	
Eyes		Eyes		Eyes		Eyes	
Right	Left	Right	Left	Right	Left	Right	Left
22	21	18	18	20	21	25	25
22	22	18	19	23	20	27	26
23	22	21	20	25	24	27	27
27	25	22	22	23	24	26	25
27	25	21	22	28	28	33	33
28	28	26	27	26	26	31	31
26	26	25	25	22	23	26	26
21	21	18	18	30	28	31	32
20	20	17	15	25	24	28	26
27	29	26	26	21	19	25	23
27	27	24	25	22	21	26	25
23	22	19	19				
25	25	20	21				

Interpretation: The odor of benzene consistently resulted in the lowering of intraocular pressure. On the other hand, the odor of left-citronellol consistently increased the tension. These results indicate that odors have a transient (10 min.) effect on ocular tension and the type of odor determines the nature of the effect.

were two essential factors in the investigation.

On the basis of former experiments and under conditions as described, variations in ocular tension of three mm. Hg or more were considered indicative of a change induced by the experimental procedure.

Rabbits were exposed to the odors for 10 to 15 minutes. A total of 24 animals was used. Of these animals, 13 were exposed to the odor of benzene and 11 to left-citronellol. Ocular tension was obtained in both eyes before and as soon as the odor was removed. Whatever changes of pressure took place as a result of contact with the odors lasted for only 10 minutes.

Of the 26 eyes exposed to the benzene odor, 19 showed a decrease in ocular tension of three or more mm. Hg. The remaining seven eyes had an increase of one to two mm. Hg. Of the 22 eyes exposed to the odor of left-citronellol, 18 showed an increase of three or more mm. Hg. The remaining four eyes had a decrease of one to two mm. Hg.

The differences in pressure before and after exposure to the odors were small, yet they were consistently lower or higher. Hence, it may be assumed that odors have an effect on intraocular pressure. The decrease or increase of pressure depending upon type of odor is significant. It suggests that there is some basic difference in odors. It also lends credence to the separation of odors into "light" and "dark" types. Whether the action of odors is upon peripheral or central mechanisms is not evident so far in this experiment (table 1).

In previous experiments we had indicated that the ciliary ganglion conveys parasympathetic stimuli which increase intraocular pressure. The superior cervical ganglion mediates sympathetic stimuli which decrease pressure.[3] These observations were utilized to determine the role of the central mechanism in the effect of odors upon intraocular pressure.

The ciliary ganglion was cauterized in three rabbits. The effectiveness of the cauterization was determined by dilatation of pupils, absence of the pupillary reflex, reten-

TABLE 2

ROLE OF NEUROVASCULAR MECHANISM ON ODOR STIMULI AS THEY AFFECT INTRAOCULAR PRESSURE
(Schiøtz tonometric readings expressed in mm. Hg)

Left Superior Cervical Ganglion Removed		Animals Narcotized with Nembutal		Animals with Cauterized Left Ciliary Ganglion	
Exposed to Odor of Benzene		Exposed to Odor of Left-Citronellol		Exposed to Odor of Left-Citronellol	
Before Exposure	After Exposure	Before Exposure	After Exposure	Before Exposure	After Exposure
20	19	19	19	18	18
19	19	21	20	18	18
20	21	19	20	17	18
22	25	21	21	17	21
18	18	21	21		
17	18	21	21		

Interpretation: Removal of ciliary (parasympathetic conveyor) and cervical (sympathetic conveyor) ganglia, which mediate most of the impulses from the diencephalon to the periphery (eyes), abolished all effects of odor on intraocular pressure. These findings suggest the involvement of the central mechanism in regulating ocular tension under conditions of exposure to peripheral stimuli (odors). The experiment indicates that the diencephalon conveyed odor impulses since nembutal interfered with their passage.

tion of corneal sensation, retention of winking reflex, and presence of normal fundi.

Exposure of these animals to the odor of left-citronellol did not result in a rise of intraocular pressure (table 2). In the presence of an intact ciliary ganglion (table 1), there was a consistent increase in pressure. Hence, it may be deduced that impulses initiated by odor of left-citronellol follow the course of the parasympathetic pathway. It may be further implied that the increase in intraocular pressure due to odor stimuli is regulated by the central mechanism of which the diencephalic centers are a part.

In a previous report[10] it was pointed out that pentobarbital sodium (nembutal) acts predominantly on the diencephalon and by virtue of this action changes in ocular tension are partly or completely inhibited. It was postulated that nembutal interrupts the conduction of impulses at the diencephalic level.

Nembutal was injected intravenously in doses of 0.45 cc. per kg. body weight into three rabbits. Prior to induction of narcosis, the animals were exposed to the odors of left-citronellol. The rise in pressure which had occurred in nonnarcotized animals did not appear in the animals given nembutal (table 2). This result gives further indication that the diencephalon is involved in conveying impulses which were originated by the odor of left-citronellol in the peripheral sensory organ.

The left superior cervical ganglion was removed in three animals. Exposure to the odor of benzene, which in normal animals produced a lowering of intraocular pressure, did not result in any changes in the three rabbits. This result suggests that the stimulus induced by the odor of benzene must travel along the disencephalic level and the sympathetic pathway. Removal of the superior cervical ganglion interrupted this flow of impulses (table 2).

In order to determine the role played by the pituitary principles in the changes of intraocular pressure produced by odors, three rabbits were exposed to the odor of left-citronellol. The three animals were killed by the injection of air. Their spinal fluid was removed and injected into three other rabbits.

Administration of this spinal fluid into the three rabbits resulted in an increase of ocular tension (table 3). These experiments

TABLE 3

ROLE OF PITUITARY PRINCIPLES IN NEUROVASCULAR MECHANISM AS IT AFFECTS INTRAOCULAR PRESSURE AFTER EXPOSURE TO ODORS
(Schiøtz tonometric readings expressed in mm. Hg)

Exposure of Rabbits to Odor of Left-Citronellol (Animals were killed and their spinal fluid was injected into other rabbits.)	
Before	After Injection
25	28
24	26
21	25
19	23
22	26
22	25

Interpretation: Changes in ocular tension due to peripheral stimuli of odor are produced by excess formation of pituitary principles which initiate the series of events which lead to changes in ocular tension.

indicate that the series of events which were initiated by odor stimuli involved a release of pituitary principles which acted upon the diencephalic centers. The stimuli traveled from the diencephalon along the sympathetic or parasympathetic pathways.

On the basis of experiments reported previously, the chain of events may be completed. Sensory stimuli of light and odor travel from the periphery to the supraoptic nucleus and from this point to the pituitary gland. Pituitary principles are released. They act upon the sympathetic or parasympathetic centers of the diencephalon. The stimuli carried along the sympathetic channels are transmitted to the vascular bed of the eye and produce contraction of the capillaries and a decrease of intraocular pressure. Stimuli which travel along the parasympathetic chain dilate the vascular bed of the eyeball and increase the pressure.

INFLUENCE OF NEUROVASCULAR MECHANISM ON EXCHANGE OF FLUIDS ACROSS CORNEA

The cornea is lined anteriorly by several layers of epithelium. On the posterior surface it is covered by endothelium. Between the anterior and posterior cells is collagenous stroma. Though the epithelium and the stroma have different properties, they appear to complement each other in metabolism and permeability. The boundary between the epithelium and stroma and between the layers of epithelium may be separated with a consequent interference in function.

Herrmann and Hickmann,[11,12] Leopold,[13] and Buschke[14] on the basis of their investigations, indicated that adhesion of epithelium to stroma may be loosened by several substances and processes, including detergent type materials, proteolytic enzymes, metabolic poisons, and local anesthetics.

Cogan and Kinsey, [15,16] using excised corneas in their studies, concluded that the epithelium-stroma boundary is permeable to water and to lipoid-soluble substances but not particularly to crystalloids.

In order to determine if the neurovascular mechanism is involved in the passage of fluids through the cornea in situ, the following experiments were performed.

After anesthetizing the cornea with one-percent butyn, distilled water was dropped over the corneas of both eyes almost continuously for a period of 15 minutes in 11 rabbits. Intraocular pressure was taken prior to and several times after the introduction of water was discontinued. There was a significant increase in pressure in both eyes of all the animals (table 4). The increase consisted of three to seven mm. Hg.

A group of five rabbits was anesthetized with nembutal. Previous experiments indicated that nembutal narcosis interrupts the flow of impulses at the diencephalic level in the neurovascular mechanism which controls ocular tension. The eyes of these narcotized animals were bathed in distilled water almost continuously for 15 minutes. Ocular tension was taken prior to and after instillation of water.

The pressure showed a significant increase in both eyes of all the animals (table 4). These results suggest that the diencephalon plays no part in diffusion of water through the cornea.

TABLE 4

INFLUENCE OF NEUROVASCULAR MECHANISM ON PASSAGE OF FLUIDS THROUGH CORNEAS OF RABBITS
(Schiøtz tonometric readings expressed in mm. Hg)

(Distilled water was applied to corneas of both eyes of rabbits for a 15-minute period. Tonometric measurements were taken subsequently.)

Application of Water Only in Normal Rabbit		Animals were Placed Under Nembutal Narcosis and Distilled Water Applied to Eyes		Left Ciliary Ganglion Cauterized		Superior Cervical Ganglion Removed	
Before	After	Before and After Water was Applied		Before and After Water was Applied		Before and After Water was Applied	
				Right Eye			
				18	18		
18	22	22	27	17	18	18	25
17	22	23	27	16	15	18	25
19	24	19	21	16	16	24	28
20	25	18	22	16	18	22	28
17	21	16	19	18	18	24	29
17	24	17	18	19	19	25	30
23	28	16	20	21	21		
23	29	16	19	21	23		
18	23	16	20	16	18		
18	25	16	17	18	18		
17	21						
16	21			Left Eye			
16	23						
16	22			13	12		
18	25			12	12		
15	21			12	13		
17	21			9	11		
18	23			9	10		
17	20			13	15		
16	19			16	21		
15	20			18	18		

Interpretation: Under normal conditions, distilled water applied to the cornea passes into the aqueous and increases ocular tension. Nembutal narcosis, which interrupts the flow of impulses in the neurovascular control of ocular tension, did not affect the increase of tension when water was applied to corneas. This suggests that the central neurovascular mechanism plays no part in diffusion of distilled water into the aqueous. Cauterization of the ciliary ganglion interfered with the rise of tension. Apparently, there is some interdependent mechanism between the ciliary ganglion and the peripheral diffusion of water.

The left superior cervical ganglion was removed in three rabbits. After anesthetizing the corneas with butyn, they were bathed for 15 minutes in distilled water. The intraocular pressure was increased in both eyes of all the animals (table 4). Apparently, the elimination of the sympathetic pathway which passes in greater part through the superior cervical ganglion did not interfere with diffusion of water through the cornea.

The left ciliary ganglion was cauterized in four rabbits. The effectiveness of cauterization was established by characteristics described elsewhere in this paper. Further evidence of the destruction of the ganglion was supplied by the low intraocular pressure obtained in the left eye in contrast to the pressure prior to cauterization. The pressure in the left eye in this group of animals was lower than in the right after cauterization.

When both eyes of the four rabbits were bathed in distilled water, no change in pressure took place (table 4). Apparently, the parasympathetic pathway, a significant part of which passes through the ciliary ganglion, is involved in the passage of water through the cornea. No explanation of these results are apparent in the present experiments.

Distilled water was applied to the corneas

TABLE 5

INFLUENCE OF NEUROVASCULAR MECHANISM ON PLASMA-AQUEOUS EXCHANGE OF FLUID: HYPERTONIC SALT SOLUTION
(Schiøtz tonometric readings in mm. Hg)

(Hypertonic salt solution (five percent) was given orally to rabbits and ocular tension taken before and after administration.)

Normal Rabbits		Left Superior Cervical Ganglion Removed and Water Given		Left Ciliary Ganglion Cauterized and Water Given	
Before Giving 5% Salt Solution	After Giving 5% Salt Solution	Before Giving 5% Salt Solution	After Giving 5% Salt Solution	Before Giving 5% Salt Solution	After Giving 5% Salt Solution
23	5	24	9	17	8
22	5	25	7	14	4
23	5	25	12	19	4
23	6	22	12	17	4
				17	4
				14	4

Interpretation: The central neurovascular mechanism does not appear to be involved in the passage of hypertonic salt solution at the aqueous-plasma barrier.

of two rabbits with congenital glaucoma (hydrophthalmos). The experiments were repeated on 12 occasions. There was no change in pressure in these animals. It is probable that diffusion of water across the abnormal corneal barrier did not take place in hydrophthalmic rabbits. It is not unlikely that permeability is determined, at least in part, by the quantity of fluid and the pressure in the anterior chamber. Another possible factor in the failure to obtain changes in pressure may be due to damage of the epithelium-stroma barrier.

NEUROVASCULAR MECHANISM AND AQUEOUS-PLASMA BARRIER

When hypertonic salt solution enters the circulation, the intraocular pressure is lowered. On the other hand, upon introduction of distilled water, the pressure is increased.[17,18]

Exchange of fluid between circulation and tissue spaces is governed among other forces by filtration as a result of blood pressure and by osmotic pressure due to molecular concentration in the blood. On this basis, water and electrolytes move from and into plasma into and out of the aqueous humor.

Moore, Scheie, and Adler,[19] studying permeability to urea of the blood-aqueous barrier, observed that permeability was determined by the pressure within the eye. Duke-Elder[17] believes that this variation in pressure is due in a large measure to the change in the volume of intraocular fluids.

The extent of this movement has been postulated by Kinsey to depend upon the concentration of water and electrolytes in the anterior chamber. Kinsey and his coworkers[20-22] calculated the ratio of this exchange by the use of isotope deuterium oxide to determine the rate of flow of water and of radioactive sodium and chloride for the movement of electrolytes in and out of the anterior chamber.

Harris and Gehrsitz,[23] admitting the exchange between plasma and the aqueous, did not accept Kinsey's concept of a balance between "a coefficient of flow and a coefficient of transfer."

In this paper we are not concerned with the physicochemical factors in the circulation and in the anterior chamber which control this exchange. The purpose of this phase of the investigation is to ascertain if any relationship exists between water and electrolyte exchange on the one hand and the neurovascular mechanism on the other.

Hypertonic salt solution in five percent concentration was given orally to nine rab-

bits in 40 cc. quantities per kg. body weight. Within 15 to 20 minutes, the intraocular pressure was reduced in two normal rabbits by 17 to 18 mm. Hg (table 5). Administration of nembutal to two other rabbits given five-percent salt solution did not interfere with the reduction of intraocular pressure.

In previous experiments, it was shown that impulses were interrupted at the diencephalic level after administration of nembutal. It may be stated, therefore, that the diencephalon plays no significant role in the exchange of water at the aqueous-plasma barrier upon administration of hypertonic salt solution.

In two rabbits, the left superior cervical ganglion was removed. After a period of 30 days, the animals were given five-percent salt solution by mouth. Intraocular pressure was taken before and after administration of the solution. The pressure was reduced by 10 to 18 mm. Hg. Since the absence of the superior cervical ganglion did not affect the reduction in pressure, it may be assumed that the ganglion and the major part of the sympathetic pathway which passes through it and hence, the neurovascular mechanism, plays no part in the passage of hypertonic solution across the aqueous-plasma barrier (table 5).

In three rabbits, the left ciliary ganglion was cauterized. After a period of 20 to 30 days, the animals were given five-percent salt solution by mouth. Intraocular pressure was taken before and after administration of the solution. The pressure was reduced from 9.0 to 15 mm. Hg. Apparently, the parasympathetic pathway, the major part of which passes through the ciliary ganglion, played no part in the passage of hypertonic solution across the aqueous-plasma barrier (table 5).

Hypotonic solution in form of distilled water was administered orally to six rabbits. The intraocular pressure became increased by six to seven mm. Hg. The animals were killed while the pressure was increased.

Spinal fluid was taken from these animals and injected into other rabbits. No significan rise of pressure was obtained. On the othe hand, spinal fluid from normal rabbits wit increased or decreased intraocular pressur produced by exposure to light or dark re sulted either in a rise or decrease in pressure. The experiment suggests that in changes of intraocular pressure produced by exchange of fluid across the aqueous-plasma barrier, the pituitary principles play no part (table 6).

TABLE 6

RELATION OF AQUEOUS-PLASMA EXCHANGE OF FLUIDS (DISTILLED WATER) TO NEUROVASCULAR MECHANISM AND PITUITARY PRINCIPLES
(Schiøtz tonometric readings in mm. Hg)

Rabbits were given distilled water orally. Ocular tension taken before and after administration of water.		Rabbits were given distilled water orally and killed. Their spinal fluid was injected into other rabbits. Tension was taken before and after injection of spinal fluid.	
Before and After Water by Mouth		Before and After Giving Spinal Fluid	
25	31	25	26
25	31	25	26
27	33	19	19
26	33	19	19
25	31	29	30
25	31	29	30

Interpretation: Passage of distilled water through the aqueous-plasma barrier bears no relation to the secretion of the pituitary principle of hyperpiesis which is concerned with an increase of ocular tension.

On the basis of these several experiments it may be inferred that more than one basic mechanism is involved in the maintenance of intraocular pressure. Whatever factors are concerned in the passage of fluid at the aqueous-plasma barrier, the neurovascular control with miopiesin and hyperpiesin play little or no part as a direct and determining factor.

SUMMARY

The purpose of this presentation was to evaluate the part that the neurovascular mechanism plays in the control of intraocular pressure. The experimental animals were exposed to several different conditions includ-

ing odors, diffusion of fluid across the cornea, and passage of water through the aqueous-plasma barrier.

Our present state of knowledge of glaucoma requires further information of the relations of these factors to each other and to the basic mechanisms controlling intraocular pressure.

There are several questions which bear upon the possible etiology of glaucoma.

Can the neurovascular mechanism maintain intraocular pressure despite the effect of stimuli based on other mechanisms?

What factors may induce periodic increases in intraocular pressure?

Of what significance in the causation of glaucoma are these periodic elevations?

Is the neurovascular mechanism involved in the ocular hypertensive episodes which are presumably associated under certain conditions with emotional stress?

These are just a few of the problems which require further study.

The investigations presented in this paper gave indication of the effect of odors on intraocular pressure. Odors did not exert a single effect. A substance such as benzene decreased the pressure. A chemical such as left-citronellol increased it. Although other mechanisms may also be involved, the experiments indicated that the effect upon pressure by the odors was controlled by the neurovascular mechanism and the pituitary principles of hyperpiesin and miopiesin.

Diffusion of hypotonic water through the cornea increased intraocular pressure in normal animals. However, there was no change in pressure in rabbits with congenital glaucoma. Corneal diffusion was found to be influenced by the neurovascular mechanism in the case of the ciliary ganglion which appeared to have some relationship to corneal diffusion.

Exchange of fluid at the aqueous-plasma barrier of hypertonic solutions did not appear to bear any relationship to the neurovascular mechanism.

These investigations indicated the presence of more than one basic control of factors which may change intraocular pressure. They showed the effects upon intraocular pressure of another sensory stimulus, that of odor. They also indicated the relationship of the neurovascular mechanism to some of the factors which are probably responsible for periodic increases in intraocular pressure.

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EXPERIMENTAL PUPIL-BLOCK GLAUCOMA*

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An experimental glaucoma resembling the iris bombé of the human eye can be produced by the insertion of a grooved lucite disc into the pupil of a rabbit eye.

HISTORY

Leber,[1] in attempting to demonstrate the formation of aqueous humor by the ciliary body, succeeded in obstructing the pupils of living animals by means of two types of metal cylinders.

One of the cylinders was short and had the same width as the pupil; a plate on one end lay behind the iris. The other cylinder was open with a plate on each end, forming a groove for the pupillary border of the iris. Apparently a manometer was attached to the hollow cylinder which was continuous with the posterior chamber.

By this technique Leber succeeded in isolating the "secretion of the ciliary processes." He found no observable quantity of fluid on the anterior surface of the iris, the anterior chamber being open; the pressure in the posterior chamber, as recorded by the manometer, was maintained at 25 mm. Hg for the duration of the experiment. In these experiments eserine was used to constrict the pupil.

Rombolotti[2] attempted to block the pupil of rabbit eyes with flat discs which were introduced into the anterior chamber. The discs were composed of celluloid (eight eyes), and stiffened silk (one eye); they varied in size from eight mm. (round) to 14 by 10 mm. (oval). Three of the nine eyes developed glaucoma within 16 to 24 days after insertion of the disc, and all nine exhibited a severe iridocyclitis. The glaucoma was accompanied by enlargement of the eye and elevation of the tension as measured by the Fick ophthalmotonometer.

METHOD

The technique employed in this study has been:

Anesthesia consisted of intravenous and intraperitoneal sodium pentobarbital and topical tetracaine. Sterile technique was attempted but, in most cases, could only be considered "clean." A keratome incision at the limbus was performed, and a lucite disc† was placed into the pupillary aperture so that the pupillary margin of the iris became inserted into a groove on the margin of the disc (fig. 1).

The discs were 1.25 to 1.5 mm. thick, and from 4.0 to 6.0 mm. in diameter. The groove was about 1.0 mm. deep. The disc was manipulated into place by an iris repositor and forceps. The wound was closed by three 6-0 black silk corneoscleral sutures.

Intravenous heparin was used preoperatively in about one third of the experiments, and seemed not to influence the result except for some reduction of the formation of fibrin during the operation. Eserine was used immediately after surgery in the early cases but was soon found to be unnecessary be-

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* Presented at the annual residents meeting of the Division of Ophthalmology, University of California School of Medicine, February, 1951.

This project was suggested by Dr. Frank W. Newell, associate in ophthalmology, Department of Ophthalmology, Northwestern University Medical School, while I was studying on the Heed Ophthalmic Foundation Fellowship. Some work was done in each of the following ophthalmology laboratories: Northwestern, Chicago; Washington University, St. Louis; College of Physicians and Surgeons, New York; and The University of California, San Francisco. Because this work was done in several different laboratories in the United States, careful control was not possible.

I wish to thank Dr. Frank W. Newell, Dr. Stefan Van Wien, and Dr. Michael Hogan for their help in preparing the paper; Miss Sylvia Ford, Miss Marian Righetti, Mr. William A. Moor, and Miss Paula Pfaff for technical assistance; and others in the various laboratories who so kindly gave their help.

† Supplied by Mr. Hugh L. Hunter, House of Vision, Chicago, Illinois.

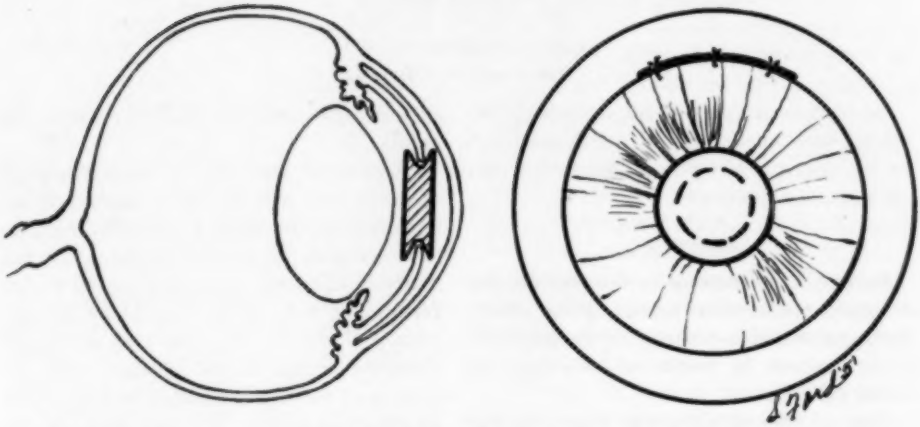

Fig. 1 (Wortham). Diagram to show ideal placement of the lucite disc in the pupil of the rabbit eye.

cause the pupil contracted rapidly as a result of the manipulations.

For measurement of the tension the rabbit was given topical tetracaine and sufficient intravenous sodium pentobarbital to produce anesthesia in the earlier experiments. This was found to be time consuming, and tonometry was later performed using topical tetracaine alone.

Schiøtz and Gradle-Schiøtz tonometers calibrated for humans were used. Struggling of the animal was an adverse factor in some instances and the figures for tonometry are, therefore, somewhat unreliable, giving only a rough indication of the tension. Tactile estimation of the tension was found to be more practical. Enlargement of the globe in many instances indicated a continued elevation of tension.

Results

The disc was placed in a total of 27 rabbit eyes (table 1); 17 eyes developed a good pupil block; eight eyes exhibited poor or questionable placement of the disc. In two eyes the disc was purposely placed eccentric to the pupil. Of the 27 eyes, nine showed complications which somewhat invalidated interpretation of the results. These consisted of iris prolapse (three eyes), hypopyon up to three mm. (three eyes), and dialysis or tiny perforation of the iris by the keratome (three eyes).

TABLE 1

Results of operation on 27 rabbit eyes

Eyes exhibiting good pupil block	17
Eyes exhibiting poor or questionable pupil block	8
Eyes in which disc was purposely placed eccentric to pupil	2
Total	27

Good block

The sequence of events in those eyes without complications and in which there was a good observable block of the pupil was:

First hour. The ocular tension became elevated, ranging between 30 and 75 mm. Hg, and very firm to palpation. The anterior chamber became markedly shallow, especially peripherally, because of advancement of the iris. In some eyes the peripheral chamber was completely absent. Varying amounts of fibrin appeared on the anterior surface of the iris in the vicinity of the disc.

Twelve hours. The early findings persisted. In addition the iris became congested so that vessels could be seen on its surface.

Twenty-four hours. The tension was continuously elevated. The cornea usually was clear or slightly hazy (fig. 2).

Forty-eight to 72 hours. The eye began to enlarge and the cornea became hazy (fig. 3). As the globe enlarged, the iris often became separated from the disc at several points, and the anterior chamber became deeper. At about this time the tension seemed to become normal to palpation.

After 72 hours. By this time the cornea usually became ectatic, showing a tendency to clear, and the anterior chamber deepened further. The iris became flatter and less congested. The tension remained normal or subnormal.

Poor block

There were eight eyes, including some with complications, in which the disc placement was poor after surgery (table 2) and a pupil block was questionable or definitely absent. The findings in these eyes varied considerably. In all, however, there was a moderate to severe iritis.

In all except two of these eyes, the tension was elevated for a part of the time. In one there was a gross prolapse of iris with a severe iritis and elevated tension. In two there was an elevation of tension for several days, followed by dislocation of the disc toward the inferior angle (fig. 4), normalization of the tension, return of the pupillary light reflex, and clearing of the eye. In two there was enlargement of the eye after several days of increased tension.

In three there was hypotony; the first of these had a hypotony for the six days of the experiment; the second had an elevated tension for 24 hours, then a subnormal tension for the next 24 hours of the experiment; the third eye of this group was hypotonic the first postoperative day and, later the same day, ruptured spontaneously at a point behind the limbus 90 degrees away from the keratome wound.

TABLE 2

FINDINGS IN EIGHT EYES EXHIBITING POOR OR QUESTIONABLE PUPILLARY BLOCK

Iritis, moderate to severe	8
Tension elevated for part of the time	6
Enlargement of eye after several days of increased tension	2
Prolapse of iris	1
Dislocation of disc into the inferior anterior chamber with normalization of tension and return of pupillary light reflex	2
Hypotony	3
For six days of experiment—1	
Following initial elevated tension—1	
For first postoperative day, followed by spontaneous perforation—1	

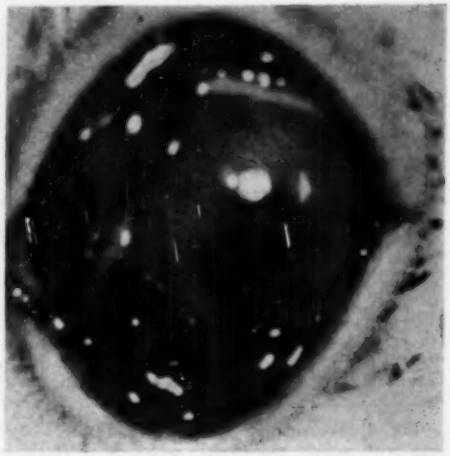

Fig. 2 (Wortham). Twenty-four hours after surgery. Disc had been well placed; good pupil block. Tension 65 mm. Hg (Schiøtz). Chemosis.

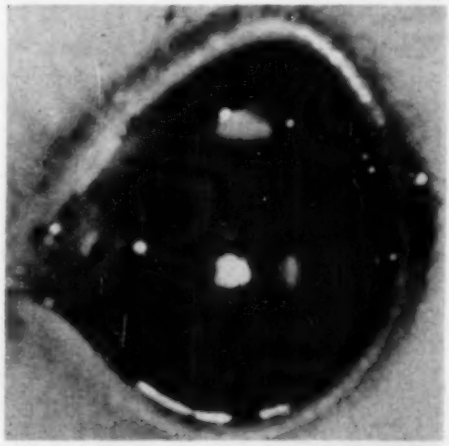

Fig. 3 (Wortham). Same eye as in Figure 2; 48 to 72 hours after surgery. Cornea hazy and disc and iris not visible in photograph. Globe beginning to enlarge.

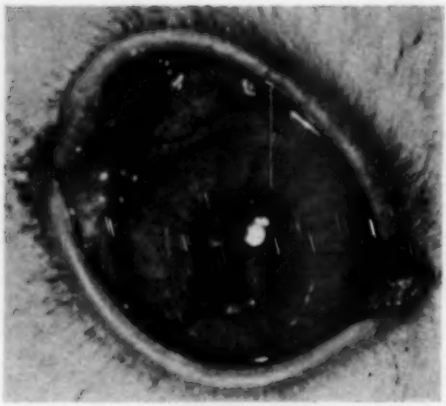

Fig. 4 (Wortham). Eleventh postoperative day; eye with poorly placed disc which is eccentric to pupil (downward). Pupillary margin of iris still partially engaged in groove.

Disc purposely eccentric

In the two eyes in which the disc was purposely placed eccentric to the pupil in the anterior chamber there was no observable pupil block, since the anterior chamber retained its original depth, and the tension remained normal. These eyes were enucleated in 24 and 48 hours respectively.

Demonstration of pupillary block by use of India ink

In an attempt to show that a block between the posterior and the anterior chamber had been accomplished, at least for large particles, a dilute suspension of India ink in saline was introduced through a needle under slight pressure into the posterior chamber of four eyes.

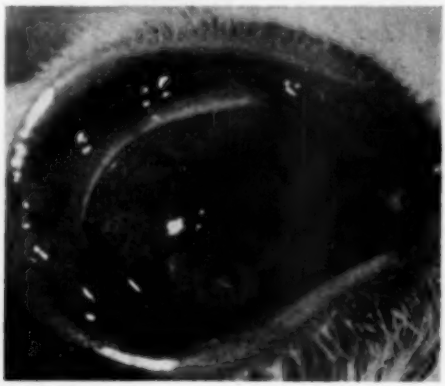

Fig. 5 (Wortham). India ink had been injected into posterior chamber one hour after surgery. Photograph at 16th postoperative hour shows no gross passage of ink into anterior chamber.

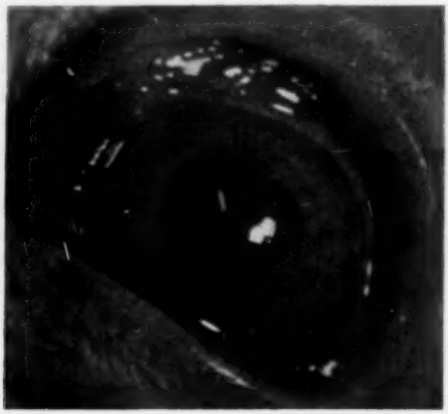

Fig. 6 (Wortham). India ink had been injected into posterior chamber within two hours after the disc had been jarred loose from iris with a needle. Photograph after 16 hours shows small area of black due to leakage around pupillary margin into anterior chamber.

In two of the eyes there was no passage of ink into the anterior chamber (fig. 5). In one of these the dark India ink could be seen in the posterior chamber through the clear lucite disc. A third eye had a good block but the disc was slightly freed from the iris in one area by a needle which had been temporarily inserted into the anterior chamber.

When India ink entered the posterior chamber of this eye, it flowed out into the anterior chamber through this leak (fig. 6). The fourth eye had a disc which was purposely inserted eccentrically (into the anterior chamber but not into the pupillary space), and injected India ink readily passed from posterior to anterior chamber.

Microscopic examination

Microscopic studies showed an inflammatory reaction in all eyes, restricted for the most part to the anterior segment.

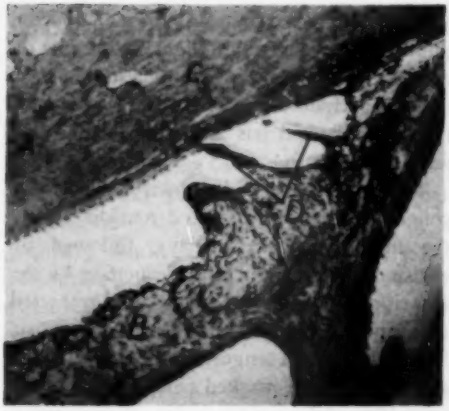

Fig. 7 (Wortham). Angle of the anterior chamber of a normal rabbit, showing (A) cornea, (B) iris, (C) Schlemm's canal, and (D) iris pillars. (×80.)

Fig. 8 (Wortham). Anterior chamber angle after 24 hours which exhibits: (A) angle with fibrin clot and suture material, (B) iris in wound, (C) iris against cornea, (D) cornea. (×43.)

Eyes with a properly placed disc

After a period of 24 hours, the angle was occluded by inflammatory cells, fibrin, and pressure of the forward-bulging iris (figs. 8 and 9). The iris showed an acute inflammation and frequently small portions were incarcerated in the wound. In those eyes allowed to progress for several days the angle of the anterior chamber was closed by peripheral anterior synechias, and the eye was diffusely enlarged.

A clear space was present at the site of the lucite disc, which was dissolved in the ether-alcohol solution used in preparation of the specimen. This space was surrounded by a thin condensation membrane to which large mononuclear phagocytes adhered (figs. 10 and 11).

In some places the membrane contained connective-tissue cells. The membrane seemed to originate from the iris and extended across the anterior as well as the posterior surface of the disc, producing a true pupil block.

The cornea was frequently thinned and ectatic if the process had been allowed to continue beyond two days. The ciliary body usually showed moderate to marked engorgement of its processes.

The posterior segment, lens, and optic nerve usually were not abnormal except for the changes due to enlargement of the globe. The optic disc of the rabbit normally shows a rounded depression. This was not deepened in those eyes becoming glaucomatous. The

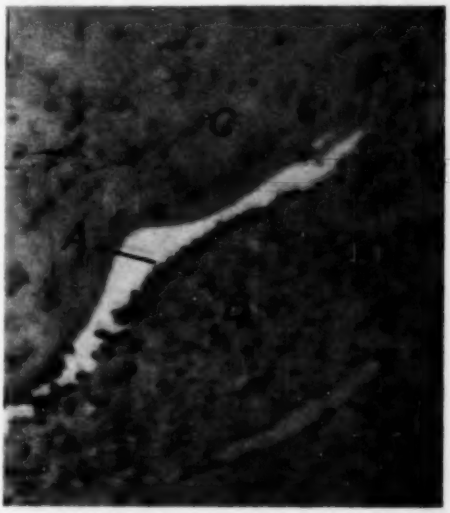

Fig. 9 (Wortham). Lower anterior chamber angle of same eye as Figure 8 (opposite wound) showing (A) extremely narrow angle containing inflammatory cells, (B) iris, and (C) cornea. (Approximately ×150.)

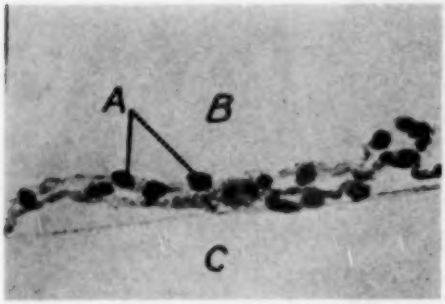

Fig. 10 (Wortham). Membrane surrounding lucite disc showing (A) mononuclear cells, (B) anterior chamber, and (C) space previously occupied by disc which has dissolved in ether-alcohol. (×460.)

eyes became enlarged uniformly due to stretching of cornea and sclera, as in infantile glaucoma.

Eyes with a questionable or poor block

Microscopic examination was possible on two of the eight eyes in this group. These two were not representative of the group since it varied widely. They were from the same animal and were subjected to surgery the same day. Enucleation was done on the 18th day.

In one eye the disc had descended to the lower angle, the tension was normal, and the pupil reacted normally to light at the time of enucleation. Pathologic examination showed marked peripheral anterior synechias, a relatively uninflamed iris and ciliary body, and an ectatic cornea.

The other eye had shown a markedly congested iris with elevated tension during the first postoperative days, followed by ectasia of the cornea, and deepening of the anterior chamber. The iris became retracted from most of the circumference of the disc. Sections showed engorgement of iris and ciliary body and marked peripheral anterior synechias.

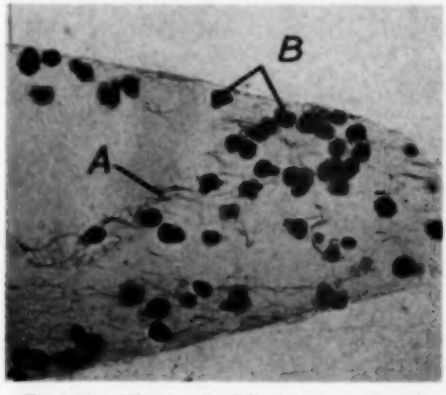

Fig. 11 (Wortham). Membrane surrounding groove of disc at the point of insertion of pupillary portion of iris: (A) fibrin and (B) mononuclear inflammatory cells. (×460.)

Fig. 12 (Wortham). Twenty-four hours after operation. Inflammatory cells in the open angle of an eye in which the disc had purposely been placed eccentric to pupil; angle opposite wound: (A) angle, (B) cornea, (C) iris. (×43.)

Eyes with an eccentrically placed disc

These two eyes were 24- and 48-hour specimens, respectively, and there was an inflammatory reaction in the anterior segment, characterized by engorgement of the peripheral iris and ciliary processes. Some acute inflammatory cells were present in the angles (fig. 12) which were otherwise open. In those sections in which it could be observed, the space where the disc had been was ec-

centric in relation to the pupil, and there was no obstruction in the pupillary opening.

Specimens examined following injection of India ink

Those specimens in which India ink had been injected into the posterior chamber demonstrated the presence or absence of a pupillary block. Two of these had a good mechanical block, and showed India-ink particles in the posterior chamber and vitreous cavity but none in the anterior chamber.

Of the other two specimens one had a satisfactory pupillary obstruction which had been broken, and the other had an eccentrically placed disc. The first showed a small amount of India ink leaking around the disc into the anterior chamber at only one point. The second showed a free passage of ink into the anterior chamber.

Summary of microscopic findings

These pathologic studies showed a moderate to marked inflammation of the anterior segment in all eyes. The angle was partially or completely blocked in eyes possessing a good pupil block, depending upon the number of days elapsed after surgery. The angle was blocked in the two eyes with poorly placed discs which were sectioned. The angle was open in eyes having an eccentrically placed disc. The mechanism of the glaucoma seemed to be a blocking of the angle of the anterior chamber as a result of obstruction of the pupil. In some eyes the glaucoma was secondary to inflammation alone.

Comment

The question of whether a continuous flow of aqueous exists from posterior chamber to anterior chamber has been discussed since the days of Leber[3] and Hamburger.[4] Leber, Ulbrich,[5] and others maintained that there is a flow anteriorly through the pupil and out of the eye through the anterior-chamber angle. Hamburger upheld the "stagnation" theory in which aqueous was thought to move through the chambers of the eye by diffusion and into and out of the eye by osmotic interchange.

The evidence in favor of a continuous flow through the pupil seems very strong today since a large number of observations have been made to support this thesis upon diseased, experimental, and near-normal eyes.

A few examples are: (1) Uveitis with iris bombé due to secluded pupil; (2) pupillary block by a dislocated lens (Friedenwald and Pierce[6] and others); (3) pupillary block by vitreous following intracapsular round-pupil cataract extraction (Reese[7]); (4) the recent experimental observations of Scheie and Frayer[8] and Otto Barkan[9] upon human and animal eyes with air injected into the anterior chamber.

Evidence in these present experiments which would seem to indicate a posterior-to-anterior chamber flow of aqueous is the following:

1. Extreme narrowing of the anterior chamber and forward displacement of the iris when the disc was accurately placed in the pupil.

2. Elevated tension (in most of the eyes) up to a stage (48 to 72 hours) when the coats of the eye failed to resist the pressure.

3. Immediate lowering of the tension and recession of the iris when the block was broken or the iris was perforated.

These eyes all became inflamed because of the operative trauma and the reaction to a foreign body. Therefore, the criticism that one should not apply conclusions drawn from such eyes to untouched rabbit or human eyes is certainly valid.

The question of whether a piece of lucite (an organic material) in the anterior chamber might cause a severe inflammation in itself has been partially answered by the observation that several eyes having a disc eccentric to the pupil recovered nicely from the operation and showed no prolonged inflammation (one up to 18 days). Stone[10]

has recently demonstrated that lucite may be tolerated by the rabbit cornea. Irritation from the foreign substance might be a factor but seemed to play a small part in the eyes observed by us.*

The normal rabbit chamber angle is long and narrow (Davis[11] and Otto Barkan[9]) and the inflammatory reaction which always followed insertion of the disc certainly helped to contribute to occlusion of the angle by synechias. For the following reasons it seems logical to suppose that the glaucoma was largely a result of the pupillary block:

1. The eyes with well-placed discs which seemingly had a pupil block usually developed elevated tension immediately and maintained it for several days.

2. The eyes with poor or questionable block varied considerably in the tension response.

3. The eyes having eccentrically placed discs developed no elevated tension in the first 48 hours.

* Since this paper was submitted for publication, Ridley has reported use of acrylic lenses placed intraocularly following cataract extraction to replace the human lens. This material, also known as Plexiglass, is approximately the same as, if not identical with, that used as the pupil-blocking disc in these experiments. (Ridley, H.: Intra-ocular acrylic lenses after cataract extraction. Lancet, **262**:118-121 (Jan.) 1952.)

Summary

1. Experimental glaucoma resembling the secondary glaucoma due to iris bombé in the human eye may be produced in the rabbit by inserting a grooved disc into the pupil.

2. After blockage of the pupil, there is forward displacement of the iris diaphragm. Injection of an India ink suspension into the posterior chamber shows that it fails to pass the obstructed pupil. The anterior chamber deepens and the tension is reduced when the disc is dislodged from the pupil or the iris is perforated.

3. In eyes with a pupillary block the elevation of tension which occurs is thought to arise from occlusion of the chamber angle chiefly as a result of forward displacement of the iris and secondarily as a result of operative inflammation.

4. In those eyes with a poor or questionable block the elevated tension which may occur is probably due chiefly to occlusion of the chamber angle by an operative inflammatory reaction.

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PROGRESSIVE MYOPIA WITH GLAUCOMA*

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The purpose of this presentation is to emphasize the fact that glaucoma is not as rare in myopes as many of us are inclined to believe and, secondly, to suggest that increased intraocular pressure may explain the cause of progressive myopia in certain cases.

Myopia may be classified simply into pathologic and nonpathologic types. The pathologic type is any myopia in which there is associated some eye disease, such as vitreous changes, uveitis, choroidal or retinal changes, retinal detachment, posterior staphyloma, or any other abnormality.

The nonpathologic type is a physiologic variation of the normal refraction, and is characterized by making its appearance in the prepuberty and adolescent years, rarely occurring under the age of five years. Usually minus-six diopters is accepted as a top limit for this normal variation.

It is of interest to mention here, that Morrison[12] found that advancing nonpathologic myopia in the first two decades of life is often associated with hypothyroidism and that, in a small group of myopes with a low basal metabolism rate, the myopia decreased on thyroid therapy. Bothman[2] also reported 30 cases of myopia with hypothyroidism, Weiner[20] reported that 50 percent of 112 cases of myopia showed hypothyroidism, and Green[12] reported that 42 percent of a series of myopes showed hypothroidism.

Jackson[9] has further classified myopia into anterior and posterior types. The anterior type of myopia is caused by distention of the globe at the anterior pole from such conditions as conical cornea and slight lens dislocations or deformities. The posterior type is due to an increased length of the anteroposterior axis and the pathologic changes are found at the temporal side of the optic nerve. This type of myopia is also often called progressive and malignant myopia.

Stocker[15] examined microscopically a great number of myopic eyes and found the following anatomic changes: (1) Thinning of the sclera at the posterior pole, (2) temporal conus or crescent, (3) temporal nerve fibers loop (that is, in cases of crescent in which the retina overlaps the choroid toward the optic disc, the nerve fibers corresponding to the most temporal part of the optic nerve happen to turn around the edge of the end of the retina, following a direct retrograde direction beneath the retina to a certain point where they turn back in a sharp angle in order to reach the optic nerve), (4) supertraction of the retina over the nasal part of the disc, (5) atrophy of the choroid, (6) retinal changes, especially cystic degeneration at the ora, (7) lacunar atrophy of the optic nerve.

It was Stocker's feeling that, if the stretching process of the sclera was on a purely mechanical basis, one would expect the stretching effect on the choroid and retina to appear when the enlargement of the globe occurred. Since choroidal and retinal atrophy begin much later, when the size of the globe becomes more stable, he felt that the mechanism was a biologic push of the retina on the sclera rather than a mechanical situation.

Many theories to explain these anatomic changes have been proposed by various authors and, as is the case in any poorly understood disease, many varied treatments have been suggested. These include full correction, base-in prisms, adduction ex-

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* From the service of Dr. Edmund B. Spaeth, chief of the Department of Ophthalmology, Graduate Hospital of the University of Pennsylvania, Philadelphia. Read at a meeting of the Philadelphia County Medical Society, Section on Ophthalmology, December, 1950.

ercises, restricted use of eyes for near work, atropinization, adrenalin, eserine, dionin, tenotomy of the internal recti, tenotomy of the obliques, paracentesis, iridectomy, excision of a scleral ring, lens extraction, ocular hygiene, calcium therapy, vitamin therapy, and endocrine therapy. A few of these theories I believe are interesting enough to mention.

Jackson[2] stated that excessive convergence without accommodation made the myopia worse. He felt that, since the anterior sclera is supported by the tendon insertions of the recti muscles, the ciliary ring, and the doubled capsule of Tenon, while the temporal part of the posterior sclera is supported by the oblique muscle insertions, the scleral softening is narrowed down to the temporal side of the nervehead. Thus, on excess convergence, the optic nerve offers resistance to the pull and the temporal side of the nervehead stretches, while the nasal side is crammed in. This situation would therefore be corrected by wearing full minus lenses or base-in prisms.

Turner offered the theory that the production of acids, proteolytic ferments, or other reagents which increase the hydration capacity of the hydrophilic colloids of the posterior segment cause a chronic water logging of the sclera, and this chemical imbalance lies behind certain forms of congestive glaucoma as well as progressive axial myopia. He feels that diseased tonsils and pathologic conditions of the ear, nose, or throat may cause a homolateral myopia and that undue physical exertion would cause further myopia by liberation of sarcolactic acid.

It was Burton's[3] opinion that increased intraocular pressure was responsible for an increased anteroposterior axis of the globe. He showed that in rabbits, by experimentally increasing the intraocular pressure, the anteroposterior diameter of the globe was lengthened and this lengthening was consistently greater in young rabbits with an elastic sclera than in adult rabbits. Lengthening was also greater the longer the increased intraocular pressure was maintained.

Burton then measured the lid pull in humans and found that of the upper lid to be 50 to 70 gm.; that of the lower lid, 40 to 50 gm.

Finally, he measured the effect exerted on intraocular pressure by the orbicularis in anesthetized rabbits. The average normal pressure of 20 mm. Hg was found to be increased to 40 mm. Hg or more when the lids were tightened and the palpebral fissure narrowed by placing the thumb on each canthus and stretching the lids.

From these experiments, it was concluded that, when under-corrected myopes squeeze to obtain better vision, they increase the intraocular pressure and stretch the sclera, thus increasing the myopia.

Carpenter[4] felt that glaucoma was caused by the same process that caused myopia; that is, increased intraocular fluids, and Dransart[4] said that myopia may assume the course of glaucoma. Weichselbaum[4] concluded that an increase in intraocular pressure and absorption of increased fluids softens the sclera, especially so if inflammatory changes coexist. The sclera then stretches, lengthening the anteroposterior axis and producing myopia more easily in the young patient.

On the other hand, if the sclera is sclerosed it does not stretch. The intraocular pressure goes up and optic cupping results, producing glaucoma in the older patient. Rolandi[4] noted that, in myopes with glaucoma, some had staphylomas with no disc changes, and Priestly-Smith[4] noted that both can be present or a staphyloma alone may be found.

It is interesting to mention here that von Hippel[4] found an increased, but stabilized, intraocular pressure in all cases of myopia over 20D. Thus, the routine prescribing of miotics for progressive myopia, as has been done in some clinics, may not be a bad idea after all.

In summarizing these theories, then, it may be said that some cases of glaucoma may be secondary to myopic changes (such as low-grade uveitis causing obstruction to the angle and outflow of fluids); in other cases the myopia is secondary to glaucoma; and, finally, the two conditions may coexist without cause and effect.

That the two conditions do coexist more frequently than we are led to believe may be borne out by the report of Lange and Gilbert[4] that myopia is present in 30 percent of simple glaucoma cases and in 10 percent of inflammatory glaucoma cases.

Knapp[4] described 32 cases of glaucoma with myopia, the myopia varying up to −10.0D. These patients had deep chambers, low tension, and cupping. De Cori[4] reported 34 cases of primary glaucoma in myopia; both the myopia and increased tensions were controlled by glaucoma surgery.

Thomas[16] reported 39 patients with normal tensions, fields, and fundi (aged 54 to 83 years), all of whom accepted minus lenses of 0.5D. to 2.5D. in addition to their corrections; 31 of these responded to miotics with return of normal vision (with their old glasses) in three weeks to three months, and remained so for six months to seven years under continuous treatment. Of the remaining eight patients, five developed frank glaucoma; in two the myopia progressed without glaucoma; one showed retinal hemorrhages. Because of these findings, he felt that increased myopia was an early sign of impending glaucoma.

As Duke-Elder[5] states: "A rapidly increasing presbyopia is an early warning of impending glaucoma," so, also, must we suspect impending glaucoma in a case of increasing myopia.

The case of increasing myopia may be more difficult to diagnose, especially when the tonometer readings are within normal. In this instance, scleral rigidity must be considered in the tension readings for apparent lower pressure readings in myopes may be due to decreased scleral rigidity and the intraocular pressure may actually be higher than recorded.

Other diagnostic tests such as visual fields, gonioscopic examinations, tension curves, and provocative tests should be performed routinely in all cases of progressive myopia. Otherwise, the presence of glaucoma may be overlooked and the patient may become blind from glaucoma when his condition is being treated as myopic choroiditis. Certainly, this would be a tragic situation when better results may be obtained in treating glaucoma than progressive malignant myopia.

The first case report exemplifies this situation.

Case reports

Case 1

History. Mr. A. V., aged 22 years, first visited the Graduate Hospital eye clinic on April 4, 1950, with the complaint of progressive loss in vision more marked in the past six months. He first began to wear glasses at the age of five years, when he was told he was nearsighted. At that time, he was seen at Wills Hospital and his atropine refraction was: O.D., −22D. sph.; O.S., −20D. sph. Examination showed the oval discs and stretched fundi of high myopia.

At the age of 14 years, he was seen by an optometrist who found his refraction to be: O.D., −32D. sph. =20/100; O.S., −34D. sph. = counting fingers at nine feet.

Since then he has been having his glasses changed frequently, until at present he is wearing a −38D. myodisc over the right eye and −30.D. over the left eye. He has a pair of contact lenses which he does not wear because they are a nuisance and do not improve his vision over the myodiscs.

Vision was: O.D., 1/60, correctible to 6/30; O.S., light perception and with correction, light perception, no projection or color perception. Refraction showed that no improvement in visual acuity over present correction could be obtained.

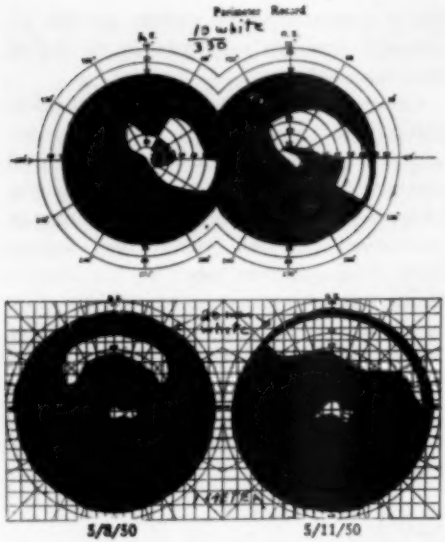

Fig. 1 (Bedrossian). Visual field study in Case 1.

Cornea. The cornea was normal. Keratometer reading: O.D., 43.50 and 42.50 (vertical); O.S., 43.37 and 42.25 (vertical).

Fundus. The right eye was seen through the patient's correcting lenses and showed a high degree of myopic choroiditis with a posterior staphyloma. The disc itself did not show any definite cupping as seen in glaucoma. In the left eye, the macular region was seen with a −24D. lens placed over the patient's correcting lenses, thus making the degree of myopia −54D. There was a very high degree of myopic choroiditis and the disc could not be visualized clearly. Only the location of the central retinal vessels could be made out.

Tension was: O.D., 40 mm. Hg (Schiøtz); O.S., 48 mm. Hg. Gonioscopy showed normal wide or open angles in both eyes. Field studies of the right eye revealed a glaucomatous defect (fig. 1).

Diagnosis. A diagnosis of progressive myopia with glaucoma was established and the patient was placed on one-percent pilocarpine, three times daily, O.U.

Course. The next day tension was: O.D., 15 mm. Hg; O.S., 40 mm. Hg. He was continued on pilocarpine and 0.035 percent DFP was added at bedtime for the left eye in which the tension remained at 40 mm. Hg in spite of increasing the strength of the DFP until about one week later when 0.075 percent DFP was used. Two hours after instillation of DFP (0.075 percent), the patient suffered severe ciliary spasm which lasted about three hours, but the following morning his tension had come down to 11 mm. Hg and he stated that the left eye no longer felt swollen. The patient's tension has remained between 13 and 19 mm. Hg in both eyes on miotic therapy up to the present time.

Case 2

Just recently we examined a boy, aged 20 months, who was found to have a compound myopic astigmatism of: O.D., −10.5D. sph. ⌒ +3.0D. cyl. ax. 90°; O.S., −15.5D. sph. ⌒ +3.0D. cyl. ax. 80°.

The anterior segment and fundus examinations of both eyes were normal, but his tension was: O.D., 20 mm. Hg, and O.S., 35 mm. Hg (Schiøtz). Further evaluation of this case will be necessary, but it is interesting to note the higher tension in the more myopic eye.

Summary and Conclusions

1. A case of progressive axial myopia of O.D., −38D. and O.S., −54D. associated with ocular hypertension is reported.

2. It is concluded that increased intraocular pressure may be one cause for the lengthening of the anteroposterior axis of the globe. Therefore, all cases of progressive axial myopia should have careful studies to rule out the presence of glaucoma. The finding of a normal tension alone would not rule out glaucoma since the increased intraocular pressure could be temporarily absorbed by a pathologic stretching of the sclera.

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LENS-INDUCED UVEITIS AND GLAUCOMA*

Part III. "Phacogenetic Glaucoma": lens-induced glaucoma; mature or hypermature cataract; open iridocorneal angle

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III. "Phacogenetic glaucoma"
(Cases 12 through 19)

Clinically this group shows: (1) Hypermature cataract; (2) normal to deep anterior chamber, or if the chamber is shallow, the angle is not closed by iris adhesions; (3) glaucoma; (4) faulty light projection; (5) removal of the lens brings about prompt relief of symptoms and good vision.

In our cases, glaucoma was sudden in onset, but in the literature insidious glaucoma also is reported by Knapp[8] and by Gifford in the discussion of a paper by Heath.

Pathologically, in this group, a hypermature lens is found and globules of lens material are seen in the vitreous or in the anterior chamber, and characteristically large eosinophilic macrophages are found around the lens, usually in the posterior lentile space or in the vitreous, and particularly obstruct-

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Part I of this paper appeared in the February, 1952, pages 177-186, and Part II in the March, 1952, issues of the Journal, pages 370-375.

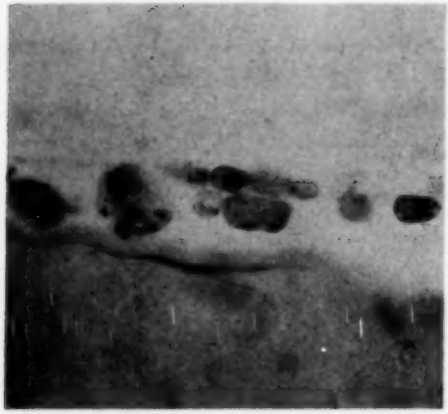

Fig. 10 (Irvine and Irvine). *Case 13.* Mononuclear cells phagocytizing hypermature lens material in region of the posterior pole of the lens.

ing the trabecular spaces. The posterior segment is remarkable in that it appears so normal. Cases 12 and 13 illustrate the clinical features.

CASE 12

1942. A 47-year-old housewife developed a cataract in the right eye. The left eye was normal. The cataract was described as a "sugary cataractous lens."

1943. The lens cortex was milky in appearance.

May 18, 1949. The lens appeared milky. There was good light projection; the anterior chamber was normal in depth. Vision in the left eye at this time was 20/20 with correction.

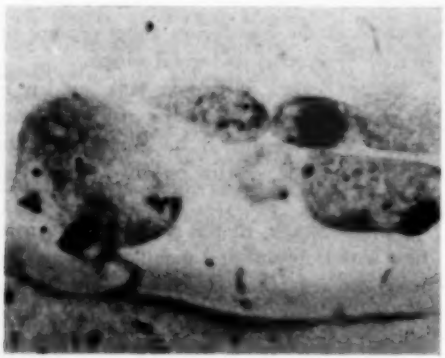

Fig. 11 (Irvine and Irvine), *Case 13.* High-power view of Figure 10.

November 6, 1949. The patient suffered acute pain in the cataractous eye.

November 7, 1949. The eye was congested; chamber was deep to normal; cornea was steamy; tension was stony hard; pupil was rigid, four mm. wide. There was a hypermature cataract with a milky cortex.

The cornea was cleared with glycerin and granular debris could then be seen floating in the anterior chamber. No keratic precipitates were seen on the cornea. There was light perception but projection was questionable. The iris appeared edematous but showed no evidence of increased vascularity.

Retrobulbar injection with novocaine and adrenalin, prostigmine (5 percent), mecholyl (20 percent), and DFP all failed to control the tension. The patient was therefore taken to the hospital for immediate removal of the cataract.

November 7, 1949. Before operation aqueous was aspirated. No cells were seen in the smear of dried aqueous. The protein content was very high, but quantitative determination was not done. The fluid did not clot spontaneously. When the section was made at operation, there appeared to be fluid vitreous.

As the capsule could not be grasped with a forceps it was opened with a cystotome and a comparatively thick piece of capsule was then removed with the forceps. Yellowish, milky fluid cortex and a large amber nucleus were expressed.

The anterior chamber was irrigated with the McKeown irrigator. The posterior capsule seemed to be quite opaque but after removal of the lens, while the patient was still on the operating table, she could see fingers. The postoperative recovery was remarkably quiet.

November 25, 1949. The sutures were removed and vision was 20/30 with correction.

January 12, 1950. Vision with correction

was 20/25 and the patient could read 5.5 point type at 14 inches. The visual field was full, and there was no evidence of uveitis or of glaucoma.

CASE 13

The second case in this group illustrates the typical pathologic findings.

1940. An 86-year-old man had a cataract extraction, left eye.

June 13, 1947. Vision in the left eye, corrected, 20/25. In the right eye there was a mature cataract, and vision was light perception only.

October 6, 1948. The patient was seen after the right eye had been red and painful for a week. Tension was 60 mm. Hg (Schiøtz); light projection faulty; cornea hazy; pupil dilated. Paracentesis was done and reopened, and this relieved the pain for two days.

October 10, 1948. The right eye was enucleated.

Description of pathologic anatomy

Microscopically, a patent penetrating wound representing the site of the recent paracentesis is seen about two mm. from the limbus temporally. The corneal epithelium is absent two mm. to each side of the wound.

Polymorphonuclear leukocytes are seen in the anterior stroma in this region. Lymphocytes and plasma cells lightly infiltrate the perilimbal connective tissue as far posteriorly as the level of attachment of the ciliary body. The endothelium is essentially normal. Descemet's membrane shows a few colloid excrescences at its extreme periphery.

The anterior chamber is partially collapsed, but its angles are open. Temporally, a fibrin strand extends from the posterior surface of the corneal wound toward the iris recess. Large, rounded, faintly eosinophilic mononuclear phagocytes, many of which contain brown pigment granules, are enmeshed in it. These cells are also seen in the iris angle, along and within the trabecular meshwork on the anterior surface of the iris filling the crypts peripherally, and temporally within the substance of the iris root.

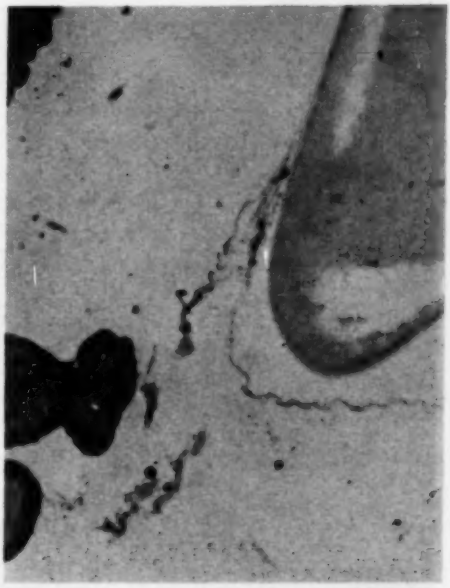

Fig. 12 (Irvine and Irvine). *Case 13.* Similar cells, macrophages containing lens substance, traversing zonular spaces.

There is minimal atrophy of the pigment epithelium of the iris as evidenced by a loss of the normal scalloped appearance. This is

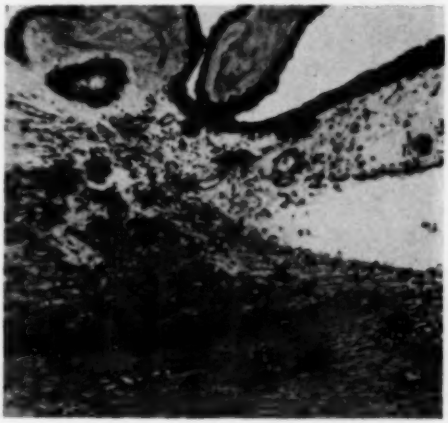

Fig. 13 (Irvine and Irvine). *Case 13.* Macrophages, containing lens substance, in the iridocorneal angle.

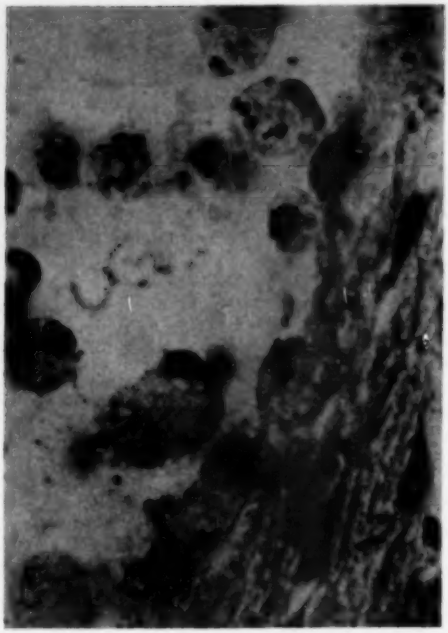

Fig. 14 (Irvine and Irvine). *Case 13.* Macrophages in iridocorneal angle (high power).

more prominent in the pupillary portions. There is moderate hyalinosis of the ciliary processes.

The lens is cataractous; its nucleus sclerotic and its cortex liquefied. The epithelium is absent centrally and anteriorly. It has undergone metaplasia to form an anterior capsular cataract which has become partially calcified.

Fig. 15 (Irvine and Irvine). *Case 13.* Macrophages obstructing trabeculum.

The lens capsule anteriorly and peripherally is abnormally thin. Posteriorly, minute areas are seen where the refractile qualities of the capsule and underlying cortex are identical, resulting in the appearance of focal dissolution of the capsule. In such places amorphous eosinophilic material outside the capsule is indistinguishable from the cortex within, suggesting microscopic dehiscences. These areas of dissolution are more apparent in the Giemsa-stained sections.

Mononuclear phagocytes, resembling those seen in the anterior chamber, are seen focally in small groups around the lens capsule, posteriorly and anteriorly, along the zonular lamellae equatorially, and adjacent to the ciliary processes.

There is some increased gliosis of the nerve-fiber layer of the retina as it approaches the optic disc. However, this layer is of essentially normal thickness, and ganglion cells are in abundance. There is a small serous separation of the retina about the papilla which probably occurred at the time of the enucleation.

The choroid shows numerous hyaline excrescences of the lamina vitrea, slight basophilic staining of the pars elastica, but lacks significant inflammatory change.

Impression. Surgical penetrating wound of eyeball, hypermature cataract; anterior capsular cataract; lens-induced glaucoma.

COMMENT. It is felt that the hemorrhagic extravasations seen occurred at the time of paracentesis. The unusual feature of this case is the almost complete absence of inflammation in the eye except for the large mononuclear phagocytes concentrated particularly in the spaces of Fontana, at the root of the iris, and in the iris crypts. These cells were seen in less abundance around the posterior capsule of the lens and at the sites where lens

material seemed to be exuding into the posterior lenticular space.

Comment on Group III

The heretofore not generally recognized features of this group are illustrated by Cases 12 and 13. There is a hypermature cataract and wide iridocorneal angle. The protein content of the aqueous is high; it contains few cells but much amorphous debris and particulate matter, suggesting that the increased protein content is due to lens matter coming through a spontaneous rent in the capsule or an area of dissolution of the capsule.

The aqueous, in spite of the protein content, does not clot. If the increased protein content had been due to an increase in the permeability of the capillaries, rather than to accumulation of products of lens degeneration, fibrinogens would also have passed from the plasma into the anterior chamber.

Pathologically, the presence of a hypermature lens and lens globules in the anterior and posterior chambers, and particularly macrophages around the lens, usually in the posterior-lenticular space, in the vitreous, and closing the meshwork of the pectinate ligament, are the differentiating points.

These macrophages appear eosinophilic, with hematoxylin and eosin, but with Giemsa stain the cytoplasm is basophilic. The posterior segment of the eye is surprisingly unaffected.

In Group III there are, in addition to the cases just discussed, two cases with pathologic reports on the eyes (18 and 19) and four in which the condition was corrected by removal of the lens (14, 15, 16, and 17).

Hypermature cataract is consistently present in this group. The products of breakdown of the lens appear to attract characteristic macrophages which tend to block the angle meshwork. This blocking of the angle meshwork is the pathogenesis of the glaucoma which is seen associated with normal to deep anterior chambers in these cases.

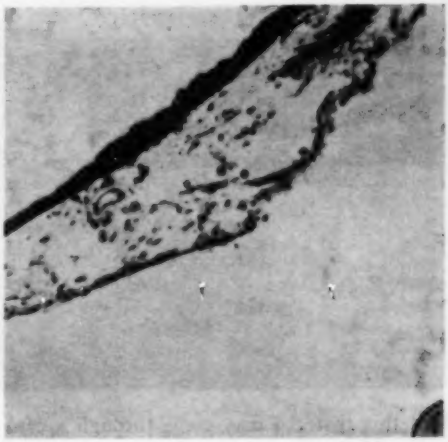

Fig. 16 (Irvine and Irvine), *Case 13.* Macrophages in iris crypts.

The increased total protein content of the aqueous represents lens matter which has escaped into the anterior chamber. We feel

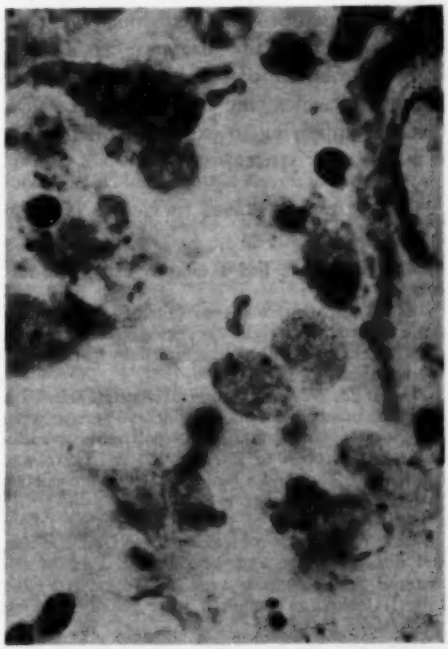

Fig. 17 (Irvine and Irvine). *Case 13.* Macrophages in iris crypts (high power).

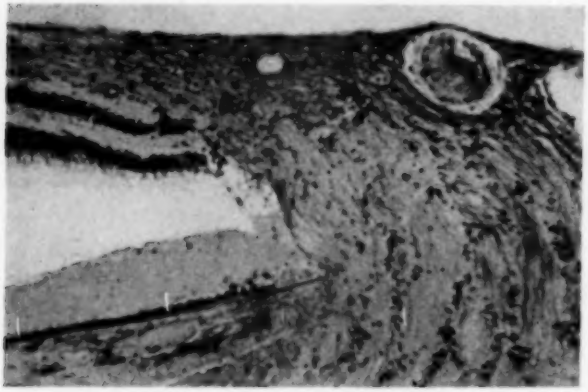

Fig. 18 (Irvine and Irvine). *Case 13.* Normal optic nerve and ganglion cells.

that this material may come through a capsule which, upon gross examination appears intact, as we have seen cases (Cases 1, 12, 14, and 17) in which the lens was removed intracapsularly, and no gross break in the capsule could be found. Microscopically, however, we have noted (Cases 13 and 19) segments of the posterior capsule where the refractile qualities distinguishing the capsule from the cortex disappear as if there were dissolution of the capsule at these microscopic sites, the hypermature cortical material appearing to exude into the posterior lenticular space.

Synopses of cases in Group III

Case 14

1927. Ja. a man, had a cataract extraction, left eye.

1939. The patient was seen (aged 64 years) with acute glaucoma of right eye; steamy cornea; deep anterior chamber; flocculent and flaky particles in the aqueous.

August 15, 1939. Aspiration of aqueous showed a moderate number of cells, of which 98 percent were lymphocytes and two percent polymorphonuclear cells; total protein of 720 mg./100 cc. There was a three-plus flare and a large amount of amorphous material floating in the aqueous.

During aspiration of the fluid, pieces of yellow material could be seen breaking loose from the lens and floating in the anterior chamber. Part of the material in the aqueous must have come from the lens. It looked as though it were actually coming through the capsule.

Iridectomy was performed. The eye seemed quite inflamed but it gradually whitened.

October 17, 1939. Cataract extraction was done. The lens capsule seemed tough and it had evidently shrunken somewhat. There was crusted cortex remaining and an amber nucleus. The hyaloid of the vitreous could be seen and it seemed thickened. There was no loss of vitreous; recovery was rapid and uncomplicated.

February 15, 1940. Vision, with correction, 20/15. Disc cupped and a corresponding field defect.

1946. Vision with correction, 20/20; tension normal.

Case 15

1940. McC., a 79-year-old business man was seen for the first time. There were early, flaky, cortical opacities in right eye; left eye, normal.

1941. Cataract mature.

December 30, 1948. Light projection questionably faulty in the right eye; patient could see Purkinje image poorly. Cataract had become milky in appearance; chamber of normal depth; no increase in intraocular pressure; patient had experienced no symptoms; left eye remained as before; vision, 20/20.

June, 1949. The right eye became painful. After two days of pain, patient came into office with acute glaucoma, deep chamber, hypermature lens. There were no keratic precipitates. The patient was treated with miotics for two days without relief. Slitlamp examination was not done, as the patient was admitted to hospital directly from home.

June, 1949. An extracapsular cataract extraction, combined with basal iridectomy, was done. The lens was hypermature. The capsule was opened with a cystotome. The cortex was seen to be broken down into a milky fluid. The nucleus was expressed and the eye irrigated with a Wright irrigator. No rent was seen in the lens capsule. Uneventful recovery.

October, 1949. Vision, with correction, 20/20; tension normal.

Case 16

1945. Ka., a woman, aged 64 years, was first seen with a mature cataract in the right eye and questionably faulty light projection left eye, normal.

July 15, 1947. An acute attack of glaucoma in the

right eye; lens appeared hypermature and shrunken; deep anterior chamber; few keratic precipitates; proliferation of vessels on iris; faulty light projection; slitlamp examination not done as patient was seen in hospital. The tension rise was partially controlled with mecholyl and prostigmine, but recurred and alcohol injection was used to control pain. This also lowered the tension. After this the iris was tremulous.

September, 1947. The eye completely quieted down, showed light projection, deep anterior chamber, hypermature morgagnian cataract; tremulous iris; no aqueous flare; few keratic precipitates. Fold in lens capsule looked as though it might have been the site of a rent in the capsule; tension normal.

June, 1948. A cataract extraction was done. Following section, the lens came forward into the pupillary space and the capsule was grasped and the lens delivered without loss of vitreous.

June, 1948. Vision, corrected, 20/30; vitreous face intact; pathologic cupping of disc and typical glaucomatous field defect. Gonioscopy showed vessels in a gauzelike membrane in the angle; tension gradually increased.

September, 1949. Cyclodialysis was done.

December, 1949. Vision, with correction, 20/50; tension controlled.

CASE 17

June 26, 1939. A man, aged 76 years, was seen for the first time. O.D., aphakic (vision 20/200, central scotoma); O.S., hypermature cataract, showing wrinkled capsule, receding lens. Crystals could be seen floating in the fluid cortex. Light projection was good.

December 15, 1939. Sudden redness and discomfort of the left eye. Cornea steamy; eye hard; pupil one third dilated; moderate aqueous flare; no keratic precipitates; deep anterior chamber; light projection faulty nasally.

December 15, 1939. 0.2 cc. aqueous withdrawn, showed only a rare lymphocyte, no polymorphonuclear cells, a total protein of 962 mg. per 100 cc. and did not clot. A small (? basal) iridectomy was done through an ab externo incision. The eye gradually whitened.

February 6, 1940. Cataract extraction; lens dislocated and delivered spontaneously in capsule without loss of vitreous. The postoperative course was uneventful.

February 28, 1940. Vitreous face intact; adherent to wound above; vitreous hazy and fundus seen poorly.

March 18, 1940. Vision, 20/70.

April 8, 1940. Vitreous clearing; vision, 20/30.

September 5, 1945. Vision, 20/20; tension normal; no evidence of uveitis; nerve slightly pale; no record of visual field.

CASE 18

1944. A man, aged 34 years, suffered a contusion to the right eye, with blurred vision thereafter.

July 7, 1949. Eye red and painful, lens dislocated into vitreous cavity, tension of 50 mm. Hg (Schiøtz); vitreous cloudy; vision, hand movements.

July 12, 1949. Eye enucleated.

Description of pathologic anatomy

On opening the eye, horizontally, a shrunken lens is seen upon the floor of the vitreous cavity.

Microscopically, the cornea is essentially normal except for attenuation of the epithelium. There is minimal lymphocytic and plasmocytic infiltration of the perilimbal connective tissue.

The anterior chamber is deep and its angle wide. However, a moderate number of rounded to oval cells, with pale-staining cytoplasm and eccentric nuclei, and distinctly staining nucleoli are seen in the chamber angle and within the tissue bordering it, obstructing the adjacent trabecular meshwork. These represent macrophages containing lens material.

The iris stroma is lightly and diffusely infiltrated with plasma cells and lymphocytes. There is minimal iris atrophy. The ciliary body and choroid show little pathologic change. The lens is not evident, and was presumably lost in sectioning.

A few mononuclear phagocytes, some resembling those seen in the anterior chamber, others containing inclusions of brown pigment, are seen in the anterior vitreous cavity adjacent to the pars plana and along zonular remnants.

The retinal vessels are essentially normal, ganglion cells are abundant. There is no evidence of gliosis of either the nerve-fiber layer or the nerve trunk.

Opinion. Traumatic posterior luxation of lens; hypermature cataract; lens-induced glaucoma (phacogenetic glaucoma).

Comment. There is minimal inflammatory response. Mononuclear phagocytes containing lens substance, within the structure of the iris and the trabecular meshwork, suggest the probable etiology of the glaucoma noted clinically, and afford a heretofore undescribed mechanism for the production of glaucoma in the presence of posterior luxation of a lens that becomes hypermature.

The poor visual acuity is probably explained on the basis of vitreous opacities arising from reaction to the dislocated lens, even though the inflammatory response in the tissue surrounding the vitreous cavity is minimal.

CASE 19

October 7, 1947. A man, aged 64 years, suffered an onset of acute, painful glaucoma of the right eye. A mature cataract was present and light projection was faulty.

October 15, 1947. Enucleation was performed.

Description of pathologic anatomy

Microscopically, the basal layer of the corneal epithelium is edematous. Lymphocytes and plasma cells lightly infiltrate the perilimbal connective tissue and episclera. The stroma and Descemet's membrane are essentially normal.

The anterior chamber is deep and the chamber

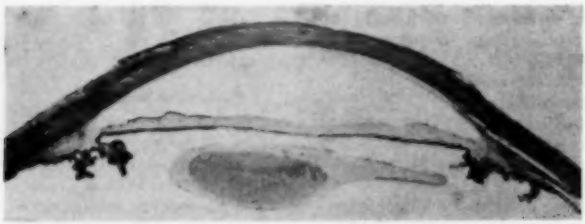

Fig. 19 (Irvine and Irvine). *Case 19.* Relatively normal anterior segment; hypermature cataract. Note open angle and relatively normal iris and ciliary body.

angles are open. There is a small amount of free blood inferiorly.

Of particular significance is the presence of mononuclear phagocytes along the border of and in the stroma of the iris root, anterior attachment of the ciliary body, and trabecular meshwork. These cells have a round to oval-shaped, somewhat eccentrically placed nucleus, showing a fine reticulum of chromatin network and distinctly staining single or multiple nucleoli.

The cytoplasm varies from moderate to large in amount and is faintly eosinophilic and slightly granular when stained with hematoxylin and eosin; basophilic with Giemsa stain. This appearance of the cytoplasm is presumably caused by the phagocytosis of lens material. Occasionally phagocytized flecks of brown pigment are seen.

There is some atrophy of the iris pigment epithelium in its pupillary portion. Occasional "clump cells" and chronic inflammatory cells are seen throughout the iris stroma. There is moderate hyalinosis of the ciliary processes.

The lens nucleus is sclerotic and is somewhat eccentrically placed in the surrounding liquefied cortex. The epithelium is decreased, flattened, and attenuated at, and just anterior to, the equator. It is absent anteriorly; a few bladder cells are seen posterior to the equator above.

Anteriorly, the capsule is abnormally thinned peripherally. In this region, the lens consists of liquefied cortex and is smaller than normal, the nucleus having settled inferiorly. A few monocytic phagocytes, resembling those seen in the anterior chamber, are scattered throughout the circumlental and postlental spaces and along the zonule.

There are areas where the continuity of the capsule is interrupted and cortex appears to exude into the posterior chamber. These areas are more obvious with Giemsa than with hematoxylin and eosin.

The retina appears normal. Ganglion cells are plentiful but are perhaps diminished above. In some sections a small amount of free blood is seen within substance of nerve-fiber layer as it enters the disc. There is little gliosis of either the nerve-fiber layer or the nerve trunk. A rare monocytic phagocyte is seen on the internal limiting membrane.

Opinion. Hypermature cataract; lens-induced glaucoma ("phacogenetic" glaucoma).

Comment. There is minimal inflammatory response throughout the tissues of the eye. The monocytic phagocytes clogging the trabecular meshwork explain the glaucoma.

Final Discussion and Summary

This report is based on the study of 20 cases, in 15 of which microscopic examinations were made. In approximately 50 percent of eyes seen in the laboratory with disorganized lens tissue in the chambers of the eye, there was no particular inflammation related to it. Of the remaining 50 percent, 20 percent showed related inflammation. In the others, the inflammation was so extensive as to obscure significant reaction to lens matter.

Of the 20 cases presented in this report, five were clinical cases in which the involved

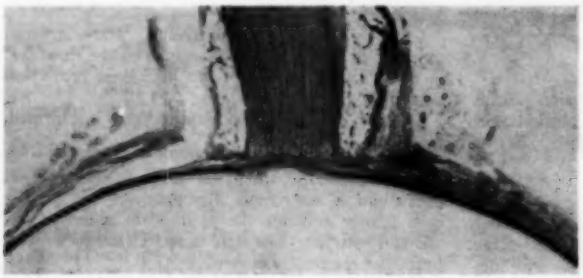

Fig. 20 (Irvine and Irvine). *Case 19.* Normal optic nerve.

eye was saved by removing the lens. Pathologic examination of the enucleated eye in the remaining 15 cases indicated that in nine of these the posterior segment was relatively normal, suggesting that these eyes might have been saved could the lens or lens remnants have been removed at the onset of the inflammation.

The characteristic types of inflammation occurring in these cases, for descriptive purposes, fall into three major classifications, referred to in the literature as: Endophthalmitis phaco-anaphylactica; phacotoxic inflammation; and "phacogenetic" glaucoma (open iridocorneal angle).

Group I, with predominantly polymorphonuclear and giant-cell reaction, showed immature cataractous lens material.

Group II, with hypermature lens tissue, or products of degeneration of a hypermature lens, escaping into the eye cavities, showed plasma-cell and macrophage-cell reaction, the polymorphonuclear cells and giant cells being less conspicuous.

In these two groups, the inflammation is primarily in the iris and around the lens material, and is presumably caused by the lens material.

In *Group III,* there is a hypermature lens with leakage of lens substance into the eye cavities, with little or no inflammatory response except for the presence of large monocytic macrophages which obstruct the drainage channels of the eye. This obstruction may account for the increased intraocular pressure in the presence of a wide iridocorneal angle.

The lack of pathologic evidence of irritation of the ciliary body is against the theory that lens material causes increased secretion of aqueous to account for the glaucoma.

Occasionally an increased number of eosinophils are seen in the reaction to lens material. From our data we cannot interpret this response. The products of lens breakdown which are most toxic remain to be ascertained.

The possibility of a low-grade bacterial or fungus infection being a factor in determining the type of response presented in the pathologic picture must be ruled out. The possibility that individual tissue reaction and not the lens material per se explains the picture must be considered.

There is considerable overlapping of the groups as we have presented them, and perhaps all cases could be classified as either lens-induced uveitis or lens-induced glaucoma (open iridocorneal angle).

From an analysis of the material presented, the following clinical diagnostic considerations are suggested:

1. If any of these reactions to lens material are recognized, the involved eye may be saved by removal of the lens or the lens remnants. This is because it is the anterior segment that is chiefly involved in the inflammation, leaving the posterior segment relatively unaffected.

Faulty light projection, often reported in these cases, is misleading, and this fact must be realized when treatment is being considered. Verhoeff has pointed this out to his students for many years, and has explained it by the fact that the milky lens acts as a diffusing screen, so that the retina is illuminated in about the same way, no matter from which direction the light is thrown upon the eye.

In some cases retinal changes can occur as demonstrated by the collections of inflammatory cells on the retina, and these might account for poor light projection. However, any toxic changes in the retina are, for the most part, reversible.

2. In patients with mature or hypermature lens, the spontaneous onset of uveitis and glaucoma should lead one to suspect that the lens is an etiologic factor.

The appearance of extremely large keratic precipitates and the finding of high protein content in the aqueous, with particular matter floating in the aqueous, indicate that there is lens substance in the anterior chamber.

Smears of the aqueous taken early in the course of the condition show relatively few cells and much amorphous debris. In spite of the high protein value there was no clot formed in four cases in which the fluid was allowed to stand undisturbed.

3. Following extracapsular extraction or injury to the eye, persistent uveitis, especially if accompanied by a sudden increase in large keratic precipitates, suggests reaction to lens material.

There may be no particular characteristics to differentiate lens-induced uveitis from other types. Nevertheless, if the uveitis persists, paracentesis and irrigation of the anterior chamber should be performed, if the zonular-capsular barrier is intact or the vitreous in such a state that irrigation would not be hazardous. Prompt relief of the inflammation confirms the diagnosis.

4. In case of injury or operation on one eye, incidental and unrelated cataract in the opposite eye may subsequently lead to reaction to lens material and be confused with sympathetic ophthalmia. The two conditions can occur coincidentally (Case 20), DeVeer,[14] and Irvine.[18] Significant differential points are:

a. Exacerbations of activity in sympathetic ophthalmia are almost invariably bilateral. In a case called to our attention by Dr. Michal J. Hogan, the reaction was bilateral and a diagnosis of sympathetic ophthalmia was made. The operated (exciting) eye was removed and pathologic examination revealed reaction to lens material only.

This mistake might have been avoided if removal of lens remnants by irrigation of the anterior chamber of the eye had been tried first. If the inflammation subsided after such irrigation, the diagnosis would be assumed to be lens reaction and not sympathetic ophthalmia.

b. A second eye does not develop lens-induced iridocyclitis unless there has been leakage of lens substance into the eye cavities. Subsequent reaction may or may not be related to sensitization to lens protein.

From the point of view of clinical appraisal, it is extremely unlikely that lens substance would escape through a capsule unless some part of the cataract were hypermature. Spontaneous inflammation in an uninjured eye should therefore be interpreted as lens-induced uveitis, and not as sympathetic uveitis, only if the lens is mature or hypermature.

Discussion by Dr. Frederick H. Verhoeff (June 12, 1950)

"My letter from which you quote was adequate for cases similar to the particular case in question but did not cover the whole subject of lens-induced ocular changes. I do not and never have approved the terms phacogenic or phacogenetic uveitis, for these mean that the uveitis produced the lens, just as pyogenic means pus producing. It has occurred to me that the term lens-induced is a satisfactory term and self-explanatory.

If you could get some scholar to make up a Greek or Latin term or a hybrid, meaning lens-induced, you would have something worthwhile, but, as a matter of fact, the English term would be more generally understood. Based on my clinical and pathologic experience my views on the subject of lens-induced uveitis and glaucoma are about as follows:

"If solid lens matter from a clear lens, immature cataract, or mature cataract is freely exposed to the aqueous by injury or operation, one of several things may happen:

"1. The lens matter may rapidly liquefy and be absorbed without causing any reaction.

"2. The lens matter may absorb very slowly yet cause little or no reaction.

"3. The lens matter may attract macrophages in great abundance but cause slight if any ocular congestion or other reaction. In these cases, large white precipitates composed of lens particles and macrophages collect on the back of the cornea and small foreign-body tubercles may form on the iris around bits of lens matter. Pus cells are

not attracted. Glaucoma may ensue. I have had patients with this condition referred to me for enucleation but have removed the lens instead and saved good vision. I have not proved that this reaction is allergic but it probably is because it does not occur in all cases. However, it is different from (4).

"4. The lens matter may cause phacoanaphylactic endophthalmitis. Here the lens matter attracts pus cells in addition to macrophages and causes a more or less severe inflammatory reaction. A similar disastrous reaction results when a hard nucleus (dead?) is left in the eye after cataract operation, either just behind the iris or dislocated into the vitreous.

"5. The liquefied lens matter in hypermature cataracts is highly toxic to the eye. It calls forth chiefly macrophages which engulf it, but sometimes also a few pus cells. The severity of the reaction depends on the amount of the liquid which escapes through the capsule. In some cases the remaining solid nucleus when exposed adds a phacoanaphylactic or similar reaction to the process.

"Usually a leaking hypermature cataract causes glaucoma along with uveitis. In some such cases the uveitis may be remarkably slight. I have always supposed that in rare cases an intact hypermature cataract could cause noncongestive chronic glaucoma. In certain cases I have noted that the nucleus has dropped below and pushed the iris forward here, blocking the angle. Perhaps thus started, the peripheral synechias extend all around.

"I have observed several cases of long-continued unilateral uveitis with immature cataract in which intracapsular extraction has promptly cured the uveitis. Chandler and Beetham have also had such cases. I cannot explain this.

"In all cases of lens-induced uveitis with or without glaucoma, the lens matter should be removed. Judgment must be exercised as to the best time to do this. If too early, the lens may not be soft enough to be removed completely; if too late, lens matter may be held in by iritic adhesions.

"A sufficiently large incision with a keratome should be made, and, in addition to irrigation, pressure upon the cornea should be applied and, as a last resort, forceps introduced into the anterior chamber.

"A cataract should always be removed before it becomes hypermature, unless the operation is contraindicated by the age or general condition of the patient.

"From a scientific standpoint it would be interesting to know more about phacoanaphylaxis. For instance, to know whether or not all the proteins of the lens are concerned, and if not which are. Also whether the pure macrophage and giant-cell reaction to solid lens matter is allergic and if so, why no pus cells are called forth. But, practically, these questions are of no importance because no matter what may be the explanation of lens-induced uveitis or glaucoma, in any particular case the cure lies in the removal of the lens matter by operation."

9730 Wilshire Boulevard.

Ophthalmic Miniature

Having been informed the night before (of) the death of a poor man in the hospital, that he had a cataract in one of his eyes, I removed the eye a short time after his death, and carried it home. On opening it, I observed that this cataract occupied the place of the crystalline, and appeared to be that body itself.

A. Maitre Jan, 1707

HEREDITARY CRANIOFACIAL DYSPLASIA

O. D. PINKERTON, M.D., AND F. J. PINKERTON, M.D.
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It is the purpose of this paper to present four cases of craniofacial dysostosis (Crouzon's disease) in a family of seven, and to discuss briefly the embryology of the cranial bones, the different types of cranial abnormalities, and their classification.

INTRODUCTION

A large group of clinical entities have been described whose common underlying cause has been premature fusion of the cranial sutures. Many have a common symptomatology manifest by varying degrees of optic atrophy, convulsions, headaches, and mental deficiency secondary to increased intracranial pressure. Other cases have presented only the external cranial deformity without any symptoms of increased pressure at any time during their life, the only evidence thereof being the convolutional markings of the skull seen roentgenographically.

Briefly, it will be recalled that the definitive skull is formed by the fusions and modifications of skeletal elements enclosing the neural tube and supporting the visceral arches. The mesenchyme in the region of the future basis cranii and in the visceral arches undergoes chondrification before ossifying; whereas, most of the side walls and cranial vault ossify directly from fibrous connective tissue. Thus the bones of the cranium are either substitution bones, replacing cartilage, or they are bones of intramembranous origin.

At the precartilage stage, the tip end of the notochord and the sensory capsules (nasal, optic, and otic) are enclosed in dense precartilaginous mesenchyme. At the cartilage state, there is a fusion of the cartilage of the basis cranii with the nasal and otic cartilaginous capsules. Later on anterior placement and fusion of the optic capsules occurs.

A period of ossification follows presently which in some parts of the cranium continues beyond birth. The chondrocranium is replaced almost entirely by bone. The membranous vault of the primitive cranium ossifies directly.

Since the chondrocranium is continuous with the cranial vault, it follows that certain of the definitive bones of the skull are both chondrocranial and intramembranous in origin. Separate centers of ossification precede the formation of the definitive bones so that each results from the fusion of these centers.[1]

The occipital, sphenoid, and temporal bones are of compound origin; that is, of both endchondral and membranous origin. The ethmoid bone is entirely of endchondral origin. The bones of the face (nasal, lacrimal, and zygomatic), and the parietal and frontal bones are of purely intramembranous origin. Abnormalities in growth, development, and shape can thus easily occur.

ETIOLOGY

The etiology of these cranial abnormalities has been discussed by Mann[2] who feels that some of these, particularly oxycephaly, are mesodermal defects of germinal origin. Other etiologic factors have included rickets, syphilis, fetal meningitis, and prenatal osteitis. None of the latter have been proved to be etiologic factors. Theories of cause have recently been briefly reviewed by Parks and Costenbader[3] who presented three cases of Crouzon's disease.

According to Ford[4] at birth in full-term infants the membranous bones of the vault are slightly separated, although the margins are in apposition at some points. Between six and 12 months the margins begin to interlock but no fusion occurs. Fusion does not occur until the third or fourth decade or

later. The anterior fontanelle closes between 14 and 22 months, and the posterior fontanelle by the second month. The interfrontal or metopic suture fuses before birth. During the first six months of life, the brain normally increases about 85 percent in weight, and during the first year about 135 percent.[5, 6]

Racial and hereditary factors cause wide variations in the size and shape of skulls in general. The grossly abnormal ones are most likely hereditary, and the result of a defective germ plasm resulting in an abnormal development of the cranial and sometimes the peripheral mesoderm. Others have no familial history.

Classification

These abnormal shapes may be grouped or classed according to which suture or sutures undergo premature synostosis. Growth of the skull occurs at right angles to the direction of the sutures. Thus, if the transverse sutures are involved, or prematurely locked, the skull cannot grow in its anterior-posterior direction. Closure of the sagittal suture prevents lateral expansion.

It is obvious from reading the literature that there is either a confusion in the classification of skull abnormalities or that, in many instances, there is such an extensive overlapping and frequency of combination of the varieties of skull defects as to make classification difficult.

A classification review seems in order, and the one given herewith is a brief résumé of that given by Pancoast, Pendergrass, and Schaeffer.[7]

A. Dysostoses of cranial bones

1. Meningocele and encephalocele.
2. Cleidocranial dysostosis (aplasia of clavicles, delayed fontanelle ossification, and hereditary transmission.
3. Hereditary craniofacial dysostosis (Crouzon's disease) manifest by cranial malformation, facial deformity, and ocular disturbances.
4. Cranial dysostosis (delayed fontanelle ossification and hereditary transmission).
5. Hereditary ectodermal dysplasia (skull changes associated with anhydrosis, deficient axillary and pubic hair, and incomplete dental development).
6. Lückenschadel (marked plasticity and decreased ossification of bones of skull).

B. Craniostenosis

1. *Turricephaly.* This is due to early synosteosis of the transverse suture with bulging in either the frontal or parietal region of the skull. The two types are:
   a. Oxycephalic, having a broad vertex and high dome.
   b. The microcephalic presenting the small round high skull.
2. *Scaphocephaly,* presenting the long narrow skull and due to stenosis of the sagittal, parietotemporal, sphenoparietal, and sphenotemporal sutures.
3. *Plagiocephaly,* the irregular or slanting type of skull and due to premature union of sutures in one half of the head and compensatory development of the opposite side.
4. *Microcephaly:* a. Microcephaly vera, or congenital underdevelopment of the brain. b. Pseudo-microcephaly due to arrest of brain development following primary brain disease.

C. Hypertelorism, presenting a low forehead and pronounced vertex with increased nasal width.

D. Platybasia, A defect of the occipital bone and cervical spine resulting from anomalous development.

Other skeletal defects and systemic disturbances often coexist. Gray and Dickey[8] reported a case of acrocephalosyndactyly which had oxycephaly, mitten hands and feet, and also a cleft palate and parrot beak.

Fig. 1 (Pinkerton and Pinkerton). The family of seven in which three members were normal and four were affected with craniofacial dysostosis.

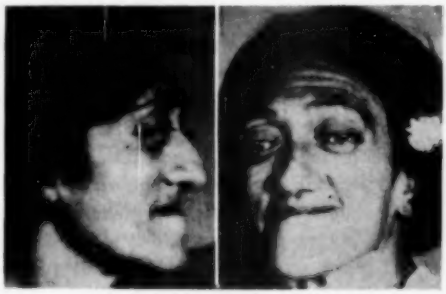

Fig. 2 (Pinkerton and Pinkerton). Mrs. Eyre S., the mother of the family, shows the typical facial contour, with prominent jaws, parrot beak, and exophthalmos.

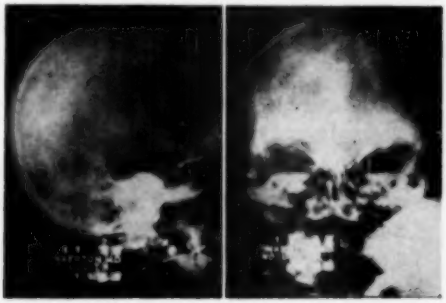

Fig. 3 (Pinkerton and Pinkerton). Skull X-ray studies of Mrs. Eyre S., the mother, showing faint digital and convolutional markings.

It is likely, too, that many of these skull abnormalities go undiagnosed because only minor abnormalities in shape sometimes occur. The patient grows to maturity and may hold a responsible position with only mild complaints and mild uncorrectible visual defect.

Clinical features

The clinical features of hereditary craniofacial dysostosis are exophthalmos, hypertelorism, psitticorhinia (parrot beak), high-arched palate which usually produces nasal obstruction, and occasionally divergent strabismus. The patient may present clinical evidence of increased intracranial pressure, or this may be evident only roentgenographically and manifest by the digital or convolutional markings. Mental deficiency and optic atrophy may or may not be present.

The severity of all or any of these clinical and objective signs and symptoms depends apparently upon just when in life certain

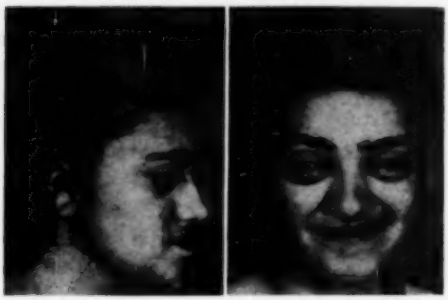

Fig. 4 (Pinkerton and Pinkerton). June S., showing exophthalmos, jaw prominence, and slight parrot-beak contour.

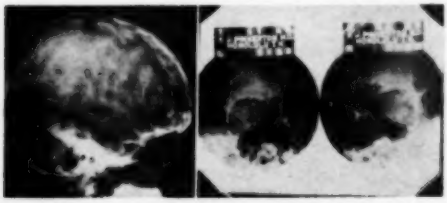

Fig. 5 (Pinkerton and Pinkerton). Skull X-ray studies of June S., showing convolutional markings, large orbital fossae, and normal optic foramina.

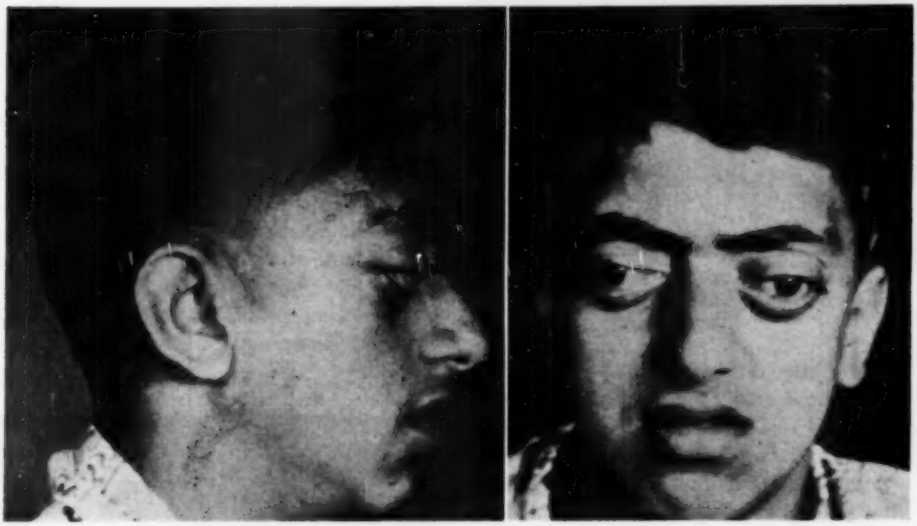

Fig. 6 (Pinkerton and Pinkerton). Joseph S., showing parrot beak, exophthalmos, and divergent strabismus.

suture synostoses occurred. Thus, if synostosis was present at birth grave physiologic disturbances would accompany the craniofacial abnormality. If synostosis occurred much later, it is likely that, although facial abnormalities were present, no serious cerebral disturbances would occur, and that optic atrophy and mental deficiency would not become manifest.

In addition to the changes mentioned, X-ray studies most often reveal a normal or slightly deeper than normal sella turcica; the air sinuses, particularly the frontal and maxillary, are obliterated or smaller than normal; the orbital fossae are circular, of wider diameter, and shallow; and the mandibles are prominent and protruding.

Present study

Four cases of craniofacial dysostosis in a family of seven are presented in tabular form (table 1). Three, including the father, were normal, and four, including the mother, were abnormal. There was no history of consanguinity. The table shows: (1) Disturbance in visual acuity varying from mild to moderate; (2) exophthalmos varying from 24 to 28.5 mm. (Hertel exophthalmometer); (3) wide interpupillary distance varying from 64 to 68 mm.; (4) normal fundi except for Anna S., aged three and one-half years; (5) small horizontal corneal measurements in three of the four abnormal cases, varying from 9.75 mm. to 10.5 (Anna S., aged three and one-half years, had unusually large corneas for her age—11.5 mm.); (6) all had poor convergence except the mother. Unfortunately, time did not permit visual field study and we were unable to get the family back for further work.

The photos of the affected members of the family (figs. 2, 4, 6, and 8) show the same general contour of the face—parrot beak, exophthalmos, and wide-set eyes. All had high-arched palates, and two had partial nasal obstruction.

The X-ray photos of the affected members (figs. 3, 5, 7, and 9) show general similarity —cranial suture obliteration (synosteosis), prominent convolutional markings, dome-shaped skull, reduction in size of paranasal sinuses (particularly frontal), relative re-

TABLE 1

ANALYSIS OF FOUR CASES OF CRANIOFACIAL DYSOSTOSIS IN A FAMILY OF SEVEN

Patient	Age	Symptoms	Visual Acuity Corrected	Exophthalmometer	Interpupillary Measurement	Refraction	Fundus	Orbital Opening (in mm.)	Horizontal Corneal Measurement (in mm.)	Npc.	Mentality	Convulsions
E.S. (father) Normal	58	None	20/20, O.U.	None	62	Hyperopia, mild	Negative	Not done	11	6 cm.	Normal	None
A.S. (mother)	40	None	20/20 × 20/25 +3	26–24	64	Astigmatism, mild, mixed	Negative	26/27	10/9.75	5 cm.	Normal	None
June S.	17	None	20/40 × 20/20 −2	27–27.5	66	Moderate myopic astigmatism R; mixed L	Negative	30/28	10.5/10	20 cm.	Normal	None
Viola S. Normal	16	None	20/20, O.U.	15–14.5	54½	Astigmatism, mild, mixed	Negative	24/24	11.5 11	5 cm.	Normal	None
Joseph S.	15	Headache, mild	20/25 −2 20/40 −1	28½–28	68	Astigmatism, myopic, mild	Negative except marked venous tortuosity, left	31/30	10/10	20 cm. 10° divergent squint near; distance exophoria	Subnormal	None
E.S. Jr. Normal	11	None	20/20, O.U.	None	55½	Hyperopia, simple	Negative	26/25	11.75/11.5	3 cm.	Normal	None
Anna S.	3½	Constantly bumps into objects	20/50 20/100	Marked but unable to measure	Unable to measure	Hyperopia, simple	Slight dirty pallor nerve-heads	25/26	11.5/11.5	Unable to obtain. Divergent squint 35° Priestly-Smith tape	Subnormal	None

tardation in facial bone development, short, pointed nasal bones, large, circular orbital fossae, and prominent protruding mandibles.

There was thinning of the skull in all but the mother. The optic foramina were normal. The pictures of E. S., E. S., Jr., and V. S. were normal.

In view of the marked visual impairment and the ophthalmoscopic evidence of chronic increased intracranial pressure in Anna S., aged three and one-half years, hospitalization for purposes of lumbar puncture and cranial surgery was recommended. This was refused.*

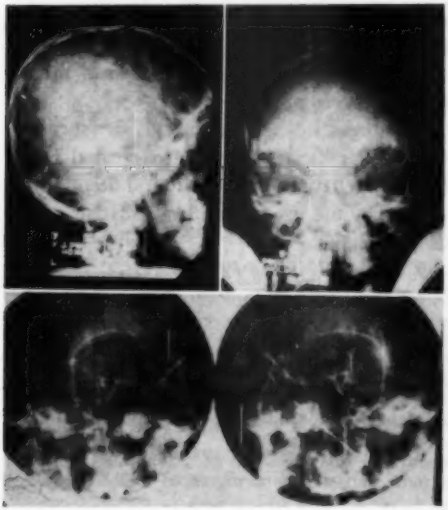

Fig. 7 (Pinkerton and Pinkerton). Skull X-ray studies of Joseph S., showing convolutional markings, large fossae, small sinuses, and normal optic foramina.

Treatment

The treatment is surgical and there are five general indications: (1) Progressive exophthalmos; (2) progressive optic atrophy or evident diminishing visual acuity; (3) progressive mental deficiency; (4) simple increased intracranial pressure with or without any of the above symptoms; (5) surgery would also be indicated in a young child with cranial deformity and digital impressions without any clinical evidence of increased pressure.

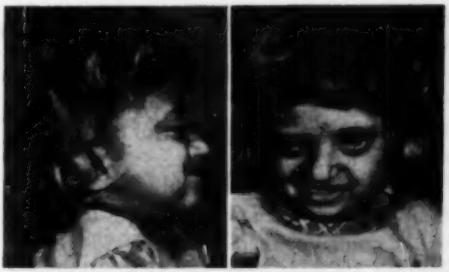

Fig. 8 (Pinkerton and Pinkerton). Anna S., showing parrot beak, jaw prominence, exophthalmos, and divergent strabismus.

Three types of operation are used at the present time:

1. Subtemporal decompression is men-

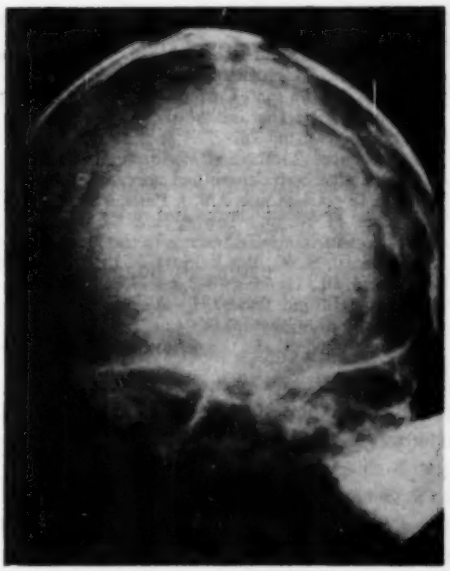

Fig. 9 (Pinkerton and Pinkerton). Skull X-ray studies of Anna S., showing convolutional markings.

*A word of warning concerning surgical procedures should be inserted at this point. One of us (F. J. P.) performed tonsil and adenoidectomy operations upon Joseph S. and June S. Gas induction followed by ether anesthesia was started, and breathing stopped almost immediately. Cyanosis developed and artificial respiration was required in both cases. After breathing was reëstablished ether anesthesia was resumed very gradually, and both operations were completed uneventfully.

tioned only to condemn it. It may work for a while but is not recommended because it is not physiologic and results in bilateral deformities due to the tense bulging of the brain, and there is the danger of exposure of the brain to external damage.

2. King[9] describes his morcellation operation wherein a "mosaic" is made of the bones of the cranial vault. The operation is recommended for oxycephaly and allied conditions of the skull due to premature closure of the suture lines. Four cases were reported with immediate improvement in all. Case 1 was operated upon five years prior to the report with good results. The mosaic is made by placing several trephine openings and connecting them with a Gigli saw. It is not recommended for cases of microcephaly.

3. Ingraham and others[10] feel that, if unrestricted cranial growth in infants with craniosynostosis is to be permitted, repeated decompression or repeated creation of artificial sutures would be required. They experimented with inert foreign substances placed between the margins of artificially created suture channels, using fibrin film, oxidized cellulose gauze, tantalum, methyl methacrylate (lucite), and polyethylene (polythene). Of these, polythene possessed the most desirable physical properties. They feel that this technique should be particularly applicable in the first few months of life because of the extremely rapid bone regrowth which fuses artificially created defects at this age.

Summary

A general discussion of cranial bone embryology, cranial abnormalities, their causation, classification, and general treatment, with particular emphasis on craniofacial dysostosis, has been presented.

Case reports of four siblings in a family of seven were presented.

Treatment, when indicated, is surgical, wherein artificial sutures are created as in the morcellation operation and kept from closing by the use of an inert substance such as polythene.

7 Young Building (9).

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LEONARDO DA VINCI: OF THE EYE*

An original new translation from *Codex D*†

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Los Angeles, California

Folio 1 recto

Why nature did not give equal power to the sense of vision.

Nature did not give equal power to the sense of vision but gave to this sense an increasing power as it nears the center. Nature did this in order not to break the law common to all the other forces which become more and more powerful as they approach the center. This is seen in the arms of the scales, where the weight advancing toward the center lessens its gravity; it is seen in columns, walls, and pillars; it is seen in heat and in all the other natural powers.

Why nature made the pupil convex, namely protruding like part of a ball.

Nature made the surface of the opening of the eye convex in order to allow the surrounding objects to imprint their images at greater angles, which could not happen if the eye were flat.

Folio 1 verso

Why the rays of the luminous bodies become larger and larger the farther they are from their source.

As rays of luminous bodies go farther from their source, they grow larger. The proof is: Let "a" be the luminous body whose image imprints itself upon the pupil of the eye which is looking at it. We say that the impression takes place in the pupil and that the same image imprints itself also upon the thickness of the superior lid and also upon the inferior lid, and from the superior and inferior lids the secondary images are reflected in the pupil of the eye.

To the pupil which receives these three images, it seems that the images reflected in it from the eyelids are reunited above and below the central image which represents the luminous body. When the eyelids close the watery fluid which always lubricates the lids in their friction with the eye fills up the angle made by the lids when they contact the pupil of the eye, and the surface of said water is concave as it is proved by the fourth of the eight propositions about water which reads: "the surface of the water contacting a wet bank will always be concave, and when the bank is dry the surface of the water will be convex."

Since this angle is formed by the contact of the eyelid with its pupil, the surface of the watery fluid which fills up said angle will be concave. And because "every concave mirror in the pyramidal course of its rays returns upside-down the image of any object" it follows that the image of the luminous body will appear upside-down.

And this is the reason why the pupil being inside the course of the pyramidal rays of the concave mirror sees the luminous pyramidal space between the lids turned upside-down. And this is also the reason why the rays of the luminous bodies become larger and larger the nearer they are to the eye. But this demonstration should be divided into its parts, to make it clearer, setting forth con-

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* From The Elmer Belt Library of Vinciana, Los Angeles, California.

† Edited by James E. Lebensohn, M.D., Chicago, Illinois. For the sake of clarity a few passages that were redundant or too obscure have been deleted.

‡ In 1949, it was suggested to me by Dr. Belt that I make a new and complete English translation of Leonardo da Vinci's *Codex of the Eye*. From the Ravaisson-Mollien facsimile edition of 1883, I first made a complete and literal transcription of Leonardo's text. The present translation, especially prepared for the American Journal of Ophthalmology, is an adaptation of my original translation.

I am greatly indebted to Dr. Elmer Belt, in whose Library of Vinciana this translation was made, and to Mrs. Kate Steinitz, librarian, for assisting me with their profound knowledge of Leonardo's work. Nino Ferrero, M.D.

ceptions and other propositions necessary to such proof.

FOLIO 2 RECTO

Whether the objects send their images to the eye with the parts in their identical proportion.

The objects do not send their images to the eye with the parts proportioned as they are in the object itself. This is proved by the ninth proposition and as between things of the same size the farthest will appear the smallest. Let "a" be the eye and "b" "c" "d" be the object. For the ninth proposition I state that "b-d," parts of this object, will appear smaller than the part "c" because they are farther from the eye than "c."

Whether the images of the objects are perceived by the sense of vision upon the surface of the eye or whether they pass into it.

The glasses of the spectacles show us how the images of the objects stop at the surface of these glasses, and from this surface they go, bending, to the surface of the eye, from which surface the eye can see the images of these objects. And this is proved to be possible because this surface is the common boundary between the air and the eye, dividing the albugineous humour from the air. If we maintain that the images of the objects stop definitely at the surface of the spectacles, one could say that through the aged man's spectacles the image appears much larger than the real object, and if it were not for the interposition of the said glass between the eye and the object, the object would appear in its natural size. Therefore, it is evident that the ray of the image of any object which is caught by the interposition of transparent bodies, will imprint itself on their surface, and from here goes out a new ray which leads to the eye the image of said object.

How the straightness of the course of the rays bends on entering the eye.

The straightness of the course of the rays bend on entering the eyes, and this occurs because at equal distance the eye sees the object bigger than it is given by the painters' rules of perspective. The perspective artist, imagining that the rays are straight, finds the things produced by his perspective much smaller than the ones seen by the eye.

FOLIO 2 VERSO

How the images of any object which reach the eye through a hole, imprint themselves upside-down on its pupil and the visual sense sees them upright.

The pupil of the eye which gets through a very small round hole the images of the bodies situated beyond said little hole, always gets them upside-down, but always the visual power sees them upright as they are. And this happens because said images pass through the center of the crystalline sphere situated in the middle of the eye: in this center they converge in one point, then they spread out over the opposed surface of this sphere without bending, and over said surface the images become upright like the objects from which they come. From there they are received by the visual power and transmitted to the mind where they are perceived.

We prove that this is right: let "a-n" be the pupil of the eye and let "p" be the small round hole made in a sheet of paper with a sharp tip of a style, and let "m" be the object situated beyond said small hole. I maintain that the upper end of the object cannot reach the upper part of the pupil of the eye through the straight line "m-a" because its passage is prevented by the interposition of the paper, but the same upper end "m" in a straight course goes through the little hole to the lower part "n" of the pupil, namely of the crystalline sphere, and from there it goes toward the center of said sphere and then

up to the upper part of the opposed side and from there reaches the mind as said before.

How and in which way the pupil receives the images of the objects without intermission of said hole.

Since, in the second demonstration the pupil "a-p" receives in "p" the upper end "t" of the image through the hole "q," if you take out the intermission of said hole, the image of "t" will imprint itself in "a" as well as in "p." Because each point of the pupil sees all the image "t-c."

FOLIO 3 RECTO

How objects on the right side would not appear right to the visual virtue, if their images did not pass through two intersections.

The object "k" arriving at "b," the surface of the pupil of the eye reaches the sense of vision through two intersections namely "n" and "s." First it passes from "b" to "d," the pupil, then from "d" to "f". It would then pass through the intersection "*n*," the center of the sphere of the pupil, but at that point it percusses the crystalline sphere before finishing its pyramid.

In this percussion the pyramid "cdn" is cut in "ef," where the base of another pyramid, namely "efo," starts, then the sides of this pyramid intersect each other in "o," thus going to the opposite part of the vitreous sphere so that the right "f" becomes left in "q" and the left "e" becomes right in "r."

Then a second intersection is made at "s" in the vitreous sphere at the apex of the pyramid "qrs" and the "r" which is right passes through the intersection "s" and becomes left in "i," and the "q" which is left becomes right in "g."

In this way the instrument of the eye shows to the extremity of the optic nerve as right is right and as left is left.

According to the significance of these two intersections it cannot be denied that all the images which rise to the surface of the pupil "anb" pass through the pupil "c-d," as proved. It follows that all the lines of the images which pass through the center of the sphere beginning at this pupil change from right to left and from left to right, which means that a right image, after having passed "e," the center of the sphere of the pupil becomes left in "t" and vice versa.

Then the vitreous sphere "rtkh" straightens the lines inside the pyramid "khr" and inverts them after the intersection of the sides of this pyramid at the points "g-l."

Why objects reduced by perspective look much smaller than natural ones.

"A-b" big becomes small in "r-t" and with the same small size it ends in "g-l" still diminished. It happens as with a concave mirror "abcd," before which the object "e-n" is placed. Its reflected image is increased in all the space "b-c." And the same happens of the second object "f-p," with the difference that "e-n" has its image straight in the mirror, and "f-t" has its image upturned and said images will be of the same size, provided their causes are the same. Before stating this as a firm proposition I want to make the experiment.

FOLIO 3 VERSO

About the way to make the experiment to show how the visual sense uses the eye as an instrument.

In order to make the experiment on how the visual sense gets the image of the objects from its instrument—the eye—a ball of glass will be made with a diameter of five eighths of a braccia (yard); from one side of it a piece should be cut out so that a face might be put into it to the ears. Then let us fix to the bottom of it a box, one third of a braccia in size; with a hole in the middle which is four times larger than the pupil of the eye—or approximately so— it does not matter. Beside this, let us make a ball of thin glass with a diameter of one sixth of a

braccia and let us fill everything with clear lukewarm water. Then put your face into the water and look into the ball and observe: you will see that this instrument sends out the images of "s-t" to your eye, as the eye sends them to the visual sense.

Assuming that the visual power is at the end of the optic nerves of which "h-m" is one, then we affirm that the visual power "m" cannot see a left object from its left part if the ray of the image of said object does not pass through the center of two spheres, namely through the sphere of the cornea "d-k" and through the sphere of the vitreous humor "xytv." Then "m," the visual virtue, will see a left object, to be represented in "x" left; the instrument of the eye cannot see the left object where it is located but through two intersections which pass through the axis of the eye as demonstrated.

How the image must necessarily reach the visual power through two intersections.

The object "a" sends its image to the visual power through the line "a-r" through the part "r" of the cornea "cdf"; then it enters through the pupil "o" and intersects there passing to the vitreous sphere in "v" and enters said sphere as the part "v-q" and then passes through the intersection "n," ending in "k" over the extremity of the optic nerve "khl" by which it is then transmitted to the mind. Here an opponent might say that the pyramid "n" intersects itself at the end of the optic nerve where small things become big.

Folio 4 recto

If the pupil of the eye gets wider and smaller depending on the major or minor amount of brightness which hits it, it is necessary that every other object gets larger or smaller. The proof is: let the wide pupil be "n-m" which sees the object "q-u" over the convex of the opening; let "a" be the reduced pupil, thus the object "q-u" will appear diminished over the convexity of the opening.

Why in the images of objects the mirror changes the right sides to left ones and the left sides to right ones.

The image of any object has in a mirror its right side opposed to the left side of the reflected object, and similarly it has the left side opposed to the right. This happens out of necessity, because any natural action is performed by nature in the shortest way and in the shortest time possible. Let "A-B" be a face sending its image to the mirror "C-D"; this face will have another face in said mirror turned toward it. The left eye "C" is opposed to the right eye "A" and, similarly, the right eye "D" will be opposed to the left eye "B."

On the contrary if one would say that the right eye of the image is opposed to the right one of the object, we should draw the line from the right side of the image to the right side of the object and similarly from the left to the left. These lines are "A-B" and "C-D" which are seen intersected and in all the intersected lines the right extremity of one is always opposed to the left extremity of the other. This result is not produced by the shortest line because the diameter of the square is always longer than its sides and here "A-D" is the diameter of the square "A-B-C-D" of which "A-C" is one of the sides and thus is demonstrated here what was necessary for the proof of such result. And this effect in the mirror is the same as if somebody looking at you with his left eye opposed to your right eye could, by a miracle, change his left to the right, like characters do, imprinting themselves on the waxes of the cornelian.

* * *

Folio 4 verso

It is true that every part of the pupil has visual power. Let us make this experiment:

Punch a hole the size of a millet seed into a piece of paper with a large needle and place this paper before the pupil of the eye at a dis-

tance of one third or one fourth of a braccia. And through this hole "r" look toward the air "p-q." Then place the needle or a similar object between the pupil of the eye and the hole of the paper in such a way that the needle will be near enough to the eye and will touch the edges of the eyelids, then move the needle forward and downward and toward the right and the left, keeping it near to your pupil; you will clearly see in the air beyond the hole that the image of the needle will make all the movements but in a contrary direction to the ones you make with the needle in the space between your eye and the hole.

The visual power is distributed all over the pupil of the eye and every point of it can conceive the nature of the objects put before the eye, otherwise it could not be thus experienced. It can be proved this way: Let us pretend that the circle "s-t" is the pupil of the eye; let "abcd" be the paper through which a hole is punched in the size of a millet grain, placed at a distance of one third of a braccia from the eye. "Let "n" be the size of the needle placed as close as possible to the pupil of the eye, moving slowly in front of the hole from "n" to "m." You will then see the image of the needle move in the open, outside the hole, contrary-wise from "q" to "p."

And this happens because in the beginning, when the needle is above in "n," its image passes through the hole "r" and occupies the air below in "q." And when the needle goes down from "n" to "m" its image in the air goes up from "q" to "p." And always the intersection of the straight lines of the image (or if you would rather say of the shadow of the needle) will be at the point "g"; and in the same way all the movements made in any direction will be transposed outside of such a hole. For this if the visual virtue were not in "s" you could not see the image of the needle in "q," and if it were not in "t" you could not see it in "p." Thus it is in all parts of the pupil.

FOLIO 5 RECTO

Concerning the great variations in the pupils of nocturnal animals which become wider during the night and smaller during the day. Proportions between the ventricle of the impressive faculty located in the brain of animals and their pupils. How it happens that a thing seen by a wider pupil looks bigger.

The nocturnal animal can see better during the night time than during the day. This, as was said before, happens mainly because there is a greater difference between the widening and constriction of their pupils than in diurnal animals; for while the pupil of man doubles the diameter of his pupil, which means that it is four times the daytime size, the diameter of the pupil of the owl widens 10 times from the size that it is during the day. Which means that it is 100 times the area that it is during the day time.

Furthermore, the ventricle located in the human brain referred to as "imprensiva" is more than 10 times the whole human eye and the pupil where the vision (or sight) comes from, is less than a thousandth part of the eye itself, while in the owl the pupil at night is much larger than the ventricle of the *imprensiva* located in its brain. The proportion between the *imprensiva* and the width of the human pupil, with the *imprensiva* 10,000 times larger than the pupil, is greater in the man than in the owl, where they are almost equal. And this man's *imprensiva* compared with that of the owl is like a great hall receiving light through a small hole, compared with a small room entirely open. Indeed, in the great hall there will be darkness at noon while in the small open one there will be brightness at midnight if the weather is not cloudy.

More convincing arguments might be brought about by the anatomic dissection of the eyes and *imprensiva* of these two animals—namely, the man and the owl.

The thing seen by a larger pupil will appear more luminous and larger. This may be

experienced by our eyes: if you make a hole as small as possible in a sheet of paper and then you bring it as close as possible to your eye and through it you look at a star, you will find that in this condition only a small part of the pupil can be made use of, and you will see the star surrounded by a large area of sky and so small that hardly anything could be smaller.

And if you will then make another hole at the edge of the paper you will see the star at the same time with your other eye also. And it will appear to you to be large, and thus in the same space of time, at one time it will appear small and the other time large.

You will also be able to see the whole sun and only moderately bright, because the more its size diminishes the more its brightness decreases as it has been set forth above, and this is the reason why large pupils can see but little during daylight because the excess of brightness impairs their visual power.

FOLIO 5 VERSO

1. About the widening and narrowing of the pupil of the eye during the daylight and during the night, which is more remarkable in the nocturnal animals than the diurnal ones.
2. About the eyes of the nocturnal animals the pupils of which widen at night incomparably more than the diurnal ones.
3. About the eye which at the same time can see dark and light, namely shining things.
4. Why the nocturnal animals can see better by night than by day.
5. About the eye of the man as compared to his brain.

* * *

The pupil of the eye changes to as many different sizes as there are differences in brightness and darkness of the objects which present themselves before it.

Nature has provided for the visual power when it is stimulated by excessive light by reducing the pupil of the eye, and by widening it like the mouth of a purse, when it is stimulated by varying degrees of darkness. Here nature acts like one who having too much light in his house closes one part of his window, more or less according to the necessity; and when it becomes dark he opens the whole window in order to see better within the house.

Here nature establishes a continual equilibrium adjusting and equalizing by widening or narrowing the pupil in accordance with the darkness or brightness which continually changes. You will see this exemplified in nocturnal animals like cats, screech-owls, and such like, which at mid-day have a small pupil and at night it becomes very large. The same happens with all the animals on the land, in the air and in the water, but incomparably more with nocturnal animals.

And if you would like to try this with a man, look intently at the pupil of his eye while you hold a lighted candle at a certain distance, then have him look at the light as you gradually bring it nearer. You will see that the nearer the light is brought the more the pupil will contract.

If the eye can see simultaneously bright and dark objects.

The crystalline humour which is inside the pupil is condensed upon meeting with shining things and becomes rarefied when meeting with dark things. When the eye closes, the retained images coming from bright objects are seen as dark objects and the dark ones are seen as though they were bright, and this happens more with weak eyes than with strong ones, but I will deal more fully with this matter later.

Nocturnal animals can see better by night than by day because the size of their eyes is greater than the whole of their brain, especially in the case of the long-eared and the short-eared owls, the white owls, screech owls, horn owls, and such like. But it does not happen with man because he has a greater brain in proportion to the size of his eyes than any other land animal, and he can see but little light after the day time has passed.

Fig. 1 (Ferrero). The only drawing of Leonardo visualizing eyeglasses. (Quaderni dell 'Anatomia V, fol. 6 r.). The original illustration is in the Windsor Castle Library, Berkshire, England. (Reprinted by gracious permit of Her Majesty the Queen.)

FOLIO 6 RECTO

1. The small size of the pupil is the reason why the image of the sun looks so very small over the surface of the water.

2. If the eye were as big as the sphere of the water, the water when struck by the sun would be entirely like the image of the sun.

3. If the sphere of the water, because of the long distance, would diminish like the stars do, the image of the sun would cover it all over.

4. How the distance causes the stars, which are many times bigger than the earth, to appear very small.

If the eye were as large as the watery sphere, it would see the image of the sun occupy a great part of the ocean.

When you move over a bridge from which you can see the image of the sun reflected in the waters of the river and if you walk about 25 braccia, you will see the image of the sun move over the watery surface for the same distance. And if you could put together all the images seen during the movements you would have but one image shaped like an enlarged beam. Now, suppose you walk around a circle of which this beam is the diameter and suppose that the whole circle is full of these images, no doubt you would see but one image the diameter of which would be 25 braccia. Now, you have to know that if a pupil had a diameter of 25 braccia it could, without moving, see in the same water an image of the sun with a circumference of 78 braccia and four seventhes.

If the eye were so far from the watery sphere that the watery sphere itself could be reduced to the dimension of a single common image of the sun, you would see as in perspective the whole sphere of water to appear as a single image of the sun. This is shown

Fig. 2 (Ferrero). Leonardo's anatomic study of the eye (Quaderni V, fol. 6 v.). The original illustration is in the Windsor Castle Library, Berkshire, England. (Reprinted by gracious permit of Her Majesty the Queen.)

in perspective, where the objects far from the eye, however, large they may be, seem to be of small size.

The same thing can be seen without any elaborate demonstration if you just raise your eyes to the starry sky. You will see in it many stars which are many times larger than the earth, yet because of their great distance they appear very small, and the brightness you see on them is not their own, but simply an image of the sun reflected on them, because the stars themselves do not have brightness, but like the watery surface they have a surface apt to receive and give back the brightness of the sun which is reflected on them.

FOLIO 6 VERSO

Does the pupil widen in order to see a larger number of things, or in order to distinguish them better? No doubt it widens to see them bigger and consequently better, because, there is no reason for such widening to occur in order to see many of them since the pupil has to judge only one thing at a time.

The pupil of the eye has its power of vision in its whole and in each of its parts. An object situated in front of the eye and smaller than the pupil itself does not occupy in the eye the place of any other object, and however thick, the object behaves like a transparent one.

Here an adversary might say that the visual power is reduced to a point and for this reason every object situated in front of the pupil and larger than the point will impair the perception of anything situated beyond itself. The convexity of the eye, in its parts turned toward a great part of the universe in front of it, could not be curved like it is if it were not equidistant from this point, and its surface could not be cut at an equal distance for this point so that each part with the same real proportions would correspond with the cutting of the angles to the proportions of the images of the objects that meet at this point.

To such a fellow we will demonstrate an experiment and then conclude with the reasoning derived from it:

Let us put in front of the pupil, as near as possible to it, a thickness of a sewing needle of medium size. We will then see that the perception of any object whatever situated behind the needle at a certain distance will not be impeded. What I am saying is entirely confirmed by experiment and it is brought forth by necessity, because if the visual power be reduced to a point, any very small object placed in front of said visual power would occupy the cognizance of a great part of the heaven, for an object placed near to the pupil and the size of half of its diameter would cover almost half of said sky.

Therefore, nature, in order that nothing may be lacking in the eyes of animals, caused this pupil to have the smallest obstructions that is possible. Otherwise they would greatly impede the visual power, because, as said be-

fore, any very small object placed in front of the pupil would occupy a large spot.

Besides, the experiment shows how meshed clothes made out of thick horsehair when placed in front of the eye do not conceal anything before them and the closer they are to the eyes the less they conceal, whereas, if the visual power were only in one point, the nearer the horse-hair cloth the larger the space of the pupil occupied by it. Therefore the experiment shows it is true that the visual power is distributed all over the pupil and each part of it functioning by itself sees beyond this horse-hair by passing around and beyond its thickness.

FOLIO 7 RECTO

Every concave place will appear darker when seen from outside than from within.

This happens because the pupil of the eye situated outside in the open is greatly restricted and the pupil of the eye situated in a dark place dilates and a narrow pupil has less visual power while the visual power increases in proportion to the dilatation of the pupil. To a pupil with weak visual power every shade will seem like utter darkness, while when its power increases complete darkness will seem bright.

Excessive light offends the eye and against this offense the visual power takes the help which everyone gets who shuts one side of the window in order to diminish the excessive brightness produced by the sun in his house.

How the pupil receives the images of the things situated before the eye only from the opening and not from the object.

(The pupil of the eye receives the images of the objects through the surface of the openings and not from the object.)

This is proved partly by means of the glasses, by which the images of the objects are magnified or reduced depending on the major or minor curving of the external surfaces of the glasses. Then it is proved by the quality of the internal and external angles made by the rays of the images, which enter the surface of the eye itself.

FOLIO 7 VERSO

Why the right object does not appear left to the eye.

The images of the objects in the eye on entering the eye bend the straightness of their rays as it happens in perspective when images pass from the density of the water to the thinness of the air.

But going back to the question that the right object does not appear left to the eye, we see clearly from the experiment that the images entering the albugineous humour through the pupil of the eye meet together in the sphere of the crystalline humour, and here we have two chances namely: the visual power resides in the crystalline humour or it widens at the extremity of the optic nerve, which gets these images and then transmits them to the common sense, like the olfactory nerves do.

If such power resides in the center of the crystalline humour, it receives the images over the surface and they are referred there from the surface of the pupil where the objects are mirrored or reflected from the surface of the uvea which bounds and closes the albugineous humour which has darkness behind its transparency, like transparent glass which is provided with the opacity of lead in order that objects may be better reflected over the surface of the glass.

If the visual power is in the center of the crystalline sphere, then all the objects sent to it from the surface of the pupil of the eye will be seen in the right spot where they are and will not change from the right to the left and will appear bigger, as shown in perspective.

And if the crystalline sphere gets images reflected from the concavity of the uvea, they will be upright, although the uvea is a concave mirror and they will be upright because the center of the crystalline sphere is con-

centric with the center of the sphere of the uvea. But it is true that images reaching the uvea from outside of the eye pass through the center of the crystalline sphere and become upside-down on reaching the uvea and the same happens to those which reach the uvea without passing through the humour.

Therefore, we might say, admitting the visual power to be at the extremity of the optic nerve, that it is clear that all the objects are straightened by the crystalline sphere, because those which were inverted in the uvea are taken and inverted a second time by the crystalline sphere which presents upright the images which were given to it inverted.

* * *

FOLIO 8 RECTO

The images of the objects placed in front of the eye reach the vitreous sphere through the opening of the pupil and they intersect inside the pupil so that the left part of the vitreous sphere is struck by the right ray of the right sphere and the same happens on the other side. Then all the rays entering the vitreous sphere contract and they get much closer together when they are on the opposite side of the sphere than when they first struck it.

This getting closer happens because the rays of the image are drawn perpendicularly when they pass from the thin to the dense, and here the albugineous humour is much more rarefied and thinner than the space enclosed by the surface of the vitreous sphere. They should, however, spread again on reëntering the same albugineous humour, but they do not follow this rule because they have to conform with the property of both the vitreous sphere from which they come and the albugineous humour to which they go.

Thus, they make a pyramid as they come out of the vitreous sphere and pass through the albugineous humour intersecting their sides at the point when they reach the visual power "g" at the extremity of the optic nerve "gs."

How the images of the objects received by the eye in its albugineous humour do intersect.

The experiment, showing that objects send their images or resemblances intersected inside the eye in the albugineous humour, is made by images of illuminated objects entering an utterly dark room through some very small round holes. If you get these images over a sheet of white paper held rather close to the small hole from inside this room, you will see on this paper all the aforesaid objects with their own shapes and colors but smaller and upside-down because of the said intersection. When these images come from a place illuminated by the sun they will have the appearance of actually being painted on the paper, which has to be very thin and seen in reverse and the little hole has to be made in a very thin sheet of iron.

Let "abcde" be the objects illuminated by the sun. Let "o-r" be the wall of the dark room with the little hole "n-m," and "s-t" be the sheet of paper whereon the rays of the objects strike. They will be inverted because their rays being straight, "*a*" right becomes left in "*k*," and "*e*" left becomes right in "*f*." The same things happen within the pupil.

FOLIO 8 VERSO

It is shown why the eye can see objects spaced laterally behind itself.

The eye can see (though it cannot recognize) the movement of two lights on the wall, while the man who is looking is leaning with the back of his neck against it.

This is because the cornea can see all those places from which it too can be seen. And all those objects that can see the cornea imprint their images on it, it being the more projecting part of the eye. And the opening, or hole, of the pupil can see and be seen from every part of the cornea itself. Therefore, the pupil can very easily receive on itself anything that the opening of the eye sends to it. However, it is true that the pupil barely recognizes the thing that imprints itself far from the center of the opening where the

central line terminates which always goes straight to all those objects whose shapes it knows will give sure and true knowledge. And this line is straight without any intersection and it is the most important of all the other lines, by which it is continuously moved to recognize anything that the other lines see but do not recognize.

In the way that the images of the objects come to the eye.

The eye has in itself only one line which is called "central," and all the images of the objects which come to the eye through this line, are perfectly seen if the long distance does not impede it. Around this line innumerable other lines adhere, which have major or minor value depending on how close or how far they are from the central line.

Function of the central line in the act of vision.

The courses of the central lines from each eye are always directed toward one point where they form an angle, more or less acute depending on the shortness or length of the distance from the eye to the seen object. If the two central lines are both directed to the object, the internal lines "s-v" and "r-y" will see the object "t" occupy two places over the wall "n-m," namely "v" and "y." But if the central lines terminate in "t," the object "x" will be seen by the two exterior adherent lines, namely "r-x" and "s-x," because the right eye sees through the right adherent line and the left eye sees through the left adherent line.

FOLIO 9 RECTO

Why a tip of a style placed across the pupil of the eye throws a great shadow upon the object itself.

The tip of a style, the diameter of its thickness being less than the diameter of the pupil, when placed across the pupil of the eye will take out more or less of the space for the other objects in proportion as it is nearer or farther from the eye itself, and this occupation will obscure but not impede the passage of the images of the aforesaid objects.

What part of the field can the eye see looking at it through a hole?

Let the two eyes look through the hole "d-c" at the field "a-c." I maintain that the two eyes together will not see of this field anything more than the space "b," the other right space "a-b" will be seen only by the left eye "g" and the other left part "b-c" will be seen only by the right eye "f."

Under what condition the two eyes will not be able to see an open field through a given hole.

The right eye "a" can see unscreened the field "e-g" and the remainder of the field "e-f" is screened by the wall "s-h" and the other eye "b" can only see unscreened the field "f-d" and the remainder field "d-g" is screened by the wall. It and the triangular space "cde" is seen by neither eye because the eye "a" is screened by the projection "e" of the lip "h" of the hole, and the eye "b" is screened by the projection of the lip "i" of the hole.

Therefore, it is demonstrated that each one of the two eyes could singly see unscreened one part of the field; the other eye throws a shadow over this field, projecting over it one of the sides of the wall. Therefore, we conclude that with only one eye the object appears less clear than with two, because if one eye is closed and sees darkness and the other is opened and sees light, the said light mingles with the darkness in the visual power, and it is not possible to get only light or only darkness, but only a mixture of darkness and light results.

For the same reason we understand why the right eye, when it sees a left object on the left side, thinks it is seen with the left eye and the sense is not aware of being deluded, and the same happens to the left eye which sees the field on the right side and the

Fig. 3 (Ferrero). Leonardo da Vinci, Ms.D., folio 9 verso. This print is made from a reversed negative in order to make Leonardo's mirror writing legible.

sense believes, however, mistakenly, to have seen the field with the right eye.

FOLIO 9 VERSO

Why the rays of the luminous bodies grow longer in proportion to the distance between them and the eye.

The length of the rays of the luminous bodies increase in proportion to the increased distance interposed between them and the eye. Here, it should first be defined what the rays of the luminous bodies are and whether they originate from the eye which looks at these bodies or whether they come out from said luminous bodies. And if we conclude that they originate from the eye it is necessary to say why and in what manner.

Why the luminous bodies show their contours with many straight luminous rays.

The rays which reveal to us the contours of the luminous bodies do not originate from these bodies but from their images which imprint themselves on the thickness of the lids of the eyes that look at the bodies. This is first proved in a persuasive manner which teaches us that a wide open eye does not see these rays around the luminous bodies, and that when the image of a star or other kind of light reaches the eye through a very small hole made in a sheet of paper placed in front of the eye, these luminous bodies never have rays.

But the real proof is given us by the ninth rule of perspective which reads: "the angle of incidence is always equal to the angle of reflection." Therefore, the rays which seem to extend from the luminous body to the point of contact with the eye looking at it, originate only when the almost closed eye looks through the narrow opening that remains between the eyelids, at the luminous body, of which the image is reflected in the thickness of the lids which are at the end of the eyelids.

After this imprint the rays rebound to the pupil of the eye, which therefore receives three images from but one luminous body, namely: two in the thickness of the lips of the eyelids and one in the pupil. These three images being very close to each other, they seem to the eye to be continuous and together with the image of the pupil.

And the proof given through experience to strengthen our proposition appears clearly when one raises or lowers one's face while keeping the eye firmly fixed upon a luminous body, for the eye, on raising the face, will lose all the lower rays from the luminous body. This occurs because the image of the luminous body does not go to imprint itself in the thickness of the lower eyelid of said eye.

Where the incident ray does not strike it cannot produce the reflected ray and, therefore, the pupil does not receive it.

The same thing will happen when one lowers the face, because then the thickness of the upper eyelid can neither see nor be seen by that luminous body and for this reason the image, as said before, cannot imprint itself there. Consequently, the eye cannot see what is not there, but it can see the images in the lower lid, which lid is seen and sees the luminous body. We have thus proved our proposition.

FOLIO 10 RECTO

About the proportions of the position of the images which imprint themselves over the eye.

The proportion of the position of the objects dispersed on fields placed before the eye, is never similar to the proportion of same images spread over the eye itself unless the said objects are equidistant from the curve of the eye. This is proved: let "aec" be the surface of the eye and "desrf" be the objects spread over the field. I maintain that "desf" the objects equidistant from the surface of the eye will be spread over the surface of the eye with the same proportion with which they are spread in this field.

And this is proved with the ninth rule of this treatise which reads: "The similar and equal triangles cut equidistant from their bases, will have the cuttings in the same proportion among themselves like the bases of the triangles have among themselves. But if these cuttings are not equidistant from their bases, then they will not follow the same proportion as in the bases."

It ensues that the triangle "h-e-r" having the cuttings "o-g" not equidistant from the base "e-r," the cutting "o-g" is not in the same proportion with "e-r."

Doubt concerning the impression of the image in the eye.

There is doubt concerning the situation of the image in the eye, namely if it appears in the concavity of the uvea or in the convexity of the crystalline sphere. I have been convinced that the image does not reflect itself in the visual power by imprinting itself in the concavity of the uvea since the angle of incidence is not equal to the angle of reflection. Therefore, it can be said that the image of "c" reaching the opening through the line "c-x," enters the pupil through the line "x-m" and it hits the crystalline sphere through the line "m-n" and it might rebound in "p," concavity of the uvea, or it may go to the crystalline sphere through the line "n-r-t."

About the images of the objects which pass through narrow holes in a dark place.

It is impossible that the images of the objects which pass through holes into a dark place do not turn upside down. This is proved by the third rule which reads: "All the parts of each dark or luminous ray are always straight."

Therefore, the part "b" of the object "a-b" passing through the hole "n" into the dark space "aqpr" will imprint itself in the same wall "p-r" in the point "c," and the other extremity of the same object "a-b," will pass through the same hole "n" and will imprint itself over the same wall "c-r" in the point "r." And thus the right extremity of said object will become left and the left extremity will become right.

Folio 10 verso

The images of the objects situated in the opposite air are all in all the air and in every part of it.

This is proved by the third proposition which reads: "All the visions made in the same quality of air are rectilinear." As it is possible to draw a straight line from the eye to each part of the air seen by the eye itself, the vision will be rectilinear.

It is further proved by what Aristotle says: "Every action of nature is made in the shortest way possible." Therefore, the vision will be made through the shortest line, namely, the straight line.

Of the images of the objects situated in the air.

The objects have their images infused in all the air seen by the objects themselves; these images are in all the aforementioned air and all in every part of it.

How the eye does not acknowledge the boundary of any object.

The eye will never acknowledge the true contour of the shape of any object situated in the far distance. This is proved: Let "a-b" be the pupil of the eye and "c-p" the object situated in front of the eye, taking notice that "c" is its upper extremity and "n-m" the background against which this extremity has to be seen by the eye.

I maintain that it is not possible to ascertain in what part of this background the extremity of said object terminates. And this is proved by means of the third rule of this treatise which reads: "The visual power is not in a point alone, as the painters who deal with perspective maintain, but it is all over the pupil through which the images of the objects enter the eye into a space larger than the pupil itself. These images, the nearer

they are to the center of the visual power situated in this space, the better they will be acknowledged, and the farther they are the less they will be acknowledged."

Therefore, if the visual power "a-b" looks at the extremity "c" of the object, the central line "r" of this visual power will see "c" in the spot "f" of the background; the upper part "s" of said visual power will see "c" in the spot "h" and the lower part of the visual power will see "cc" in the spot "d," and thus "c" spreads all over the background "d-h."

For this reason said extremity is not acknowledged by the eyes because the sense of visual power is spread all over this virtue, which offers to the judgement a vague end of this extremity and so much more or less vague as it is nearer or farther from the central line of the visual power and so much more or less vague as it is farther or nearer to the eye.

Addenda

The *Codex D* does not include all of Leonardo's observations on the eye and optics. Some of these other sources are accessible in English in the works by Richter, Jean Paul: *The Literary Works of Leonardo da Vinci*, New York, Oxford University Press, 1939 (volume 1, chapters 2 and 3 on perspective, light, and shade); and by MacCurdy, Edward: *The Notebooks of Leonardo da Vinci*, New York, Reynal and Hitchcock, 1938 (volume 1, chapter on "Optics," pp. 233-275).

Innumerable notes on optics are scattered throughout Leonardo's notebooks: *Codex Atlanticus* in the Ambrosiana, Milan; *Manuscripts A-M* at the Institut de France, Paris; *Codex Arundel 263* in the British Museum; in *Fogli A, B,* and *Quaderni d'Anatomia* at Windsor Castle.

The most important optical drawings outside of *Codex D* can be found in *Quaderni V*, folios 6 v and 8 r (the former shows Leonardo's only drawing representing the vision through eye glasses); in *Codex Atlanticus*, folio 396, the drawings for the construction of a lens grinder for telescopes is of special interest; in *Fogli B*, folio 42 r are marvelous drawings of skulls showing the orbital cavities; and a drawing in the Library of Torino demonstrates the proportions of the eye.

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PROGRESSIVE ESSENTIAL ATROPHY OF THE IRIS

CASE HISTORY WITH PATHOLOGIC REPORT

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The microscopic findings in progressive essential atrophy of the iris have been described in eight previous case reports,[1] thus occurring with such infrequency as to warrant the detailed description which follows. Altogether, fewer than 50 authenticated cases of this bizarre type of iris atrophy have been reported in the world literature and most of these have appeared since de Schweinitz's[2] classical description of his case in 1926.

Henderson and Benedict[3] (1940), after an extensive search of the literature, could find only 32 cases reported. Of these, the majority did not meet the requirements of the first of these authors' three group classifications.

The 12 cases which comprised their first group had typical unilateral atrophy of all the iris layers, usually with true hole formation, without inflammation or other discoverable cause. Secondary glaucoma developed later in all but two of the cases.

In the second group, they placed those cases which were probably primary atrophies but which were first seen after the development of the glaucoma.

The remaining eight cases presented signs of associated active inflammation with "features not compatible with the diagnosis of essential progressive atrophy." These were placed in group three.

CASE REPORT

On November 7, 1936, Mrs. J. A., a 36-year-old housewife, stated that six to eight months previously her left pupil gave the appearance of a "cat's eye," seemingly coming on over night. She had at no time had pain or inflammation in the eye.

The right eye was normal. The left eye showed a normal conjunctiva and clear cornea. The anterior chamber was of normal depth. The pupil was elongated in its vertical plane and gave a normal response to light stimulus. There was localized atrophy of the iris (fig. 1) extending from the pupillary margin to its base with the pupil displaced upward in the 11-o'clock meridian. Media and fundus were normal.

Tension was: R.E., 25 mm. Hg (Schiøtz); L.E., 20 mm. Hg.

Refraction showed: R.E., +1.0D. sph. ⊃ +0.25 D. cyl. ax. 90° = 20/20; L.E., +2.25D. sph. ⊃ 0.75 D. cyl. ax. 120° = 20/25.

Her general physical examination brought out that, after the birth of her only child, she had had several miscarriages. All laboratory tests were negative. A final diagnosis of chronic myocardial disease was made.

By December 3, 1938, the bridge of atrophic iris had retracted and only a narrow rim of the sphincter projected beyond the rim of the limbal ring in the upper nasal quadrant. A new atrophic area was progressing from the iris angle into the body of the iris with baring of the pigment layers (fig. 2) in the six-o'clock meridian.

Tension was: R.E., 22 mm. Hg (Schiøtz); L.E., 24 mm. Hg.

Corrected vision was: R.E., 20/15; L.E., 20/20—.

On February 26, 1942, examination showed loss of topography and iris pigment over the entire nasal half of the iris. Ectropion uveae and patches of retinal pigment were present (fig. 3). Intraocular pressure and vision remained normal.

On December 29, 1944 (eight and one-half years after onset), the patient made her first complaint of discomfort and blurring of the vision. Moderate injection of bulbar conjunctiva with corneal edema was present. There were no keratic precipitates, aqueous cells, or other evidences of inflammation. Broad anterior synechias could be seen in the upper chamber angle. The temporal one half of the iris continued to appear normal with perhaps some increased thinning of the nasal portion.

Tension was: R.E., 20 mm. Hg (Schiøtz); L.E., 45 mm. Hg.

By January 7, 1945, there was no appreciable lowering of the pressure to either pilocarpine, or pilocarpine, eserine, and dionin combined. An Elliot trephining operation was made in the one-o'clock meridian and a large piece of "normal" iris excised. Postoperative recovery uneventful.

On October 26, 1946, there was a good filtration bleb. Intraocular pressure and vision remained normal. The iris showed further atrophy with the formation of ragged holes in the lower central sector (fig. 4). Slitlamp examination with high-power objective revealed a uniform distribution of round

rust-colored dots suggestive of cell nuclei over the atrophic nasal half of the iris.

Corrected vision was: R.E., 20/20; L.E., 20/30—.

October 3, 1950 (five and one-half years after trephination). There had been intermittent pain and blurring of the vision for several months. Bullous keratitis and obvious increase in tension were present. The conjunctiva in the region of the trephination was flat and gave no evidence of filtration (fig. 5).

Tension was: R.E., 17 mm. Hg (Schiøtz); L.E., 57 mm. Hg. Corrected vision was: R.E., 20/20; L.E., 20/200.

Because of the patient's advanced myocardial disease, further operative attempts to decompress the globe were not considered advisable.

October 6, 1950, all medicinal efforts to control the pressure were ineffectual and the globe was enucleated under two-percent novocain local anesthesia.

MICROSCOPIC REPORT (Kresge Eye Institute)*

Cornea. There is variation in the thickness of the corneal epithelium with characteristic bullous keratitis evident. Reduplication of Bowman's membrane is noted in certain areas. Scar tissue formation is seen. There are deposits of inflammatory cells and pigment cells in the endothelial surface. The periphery of Descemet's membrane shows moderate localized thickening.

In the limbal region on one side there is a large globular defect which is continuous with the anterior chamber. It is lined by endothelium and extends two thirds of the distance through this region. Attached to its anterior border on the chamber side is a remnant of the iris.

Overlying the globular defect there is new fibroblastic proliferation with inflammatory cell infiltration and hemorrhage. Opposite the operative wound there is marked anterior synechia with proliferation of Descemet's membrane about this angle onto the anterior surface of the iris.

Iris. The iris is absent on one side in many sections due to the operative procedure. Remnants of iris are noted in some sections on the anterior lip of the trephine opening. The iris surface presents collections of inflammatory cells in nodule formation with tendency toward organization of these nodules. There is a new fibrotic membrane on the anterior surface.

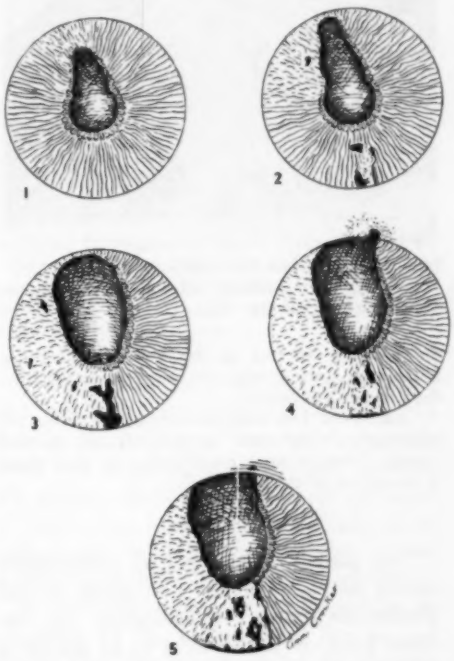
Ectropian uveae is present. The vessels show sclerotic changes. The iris in many areas is extremely thin and atrophic and in some areas there is complete loss of iris substance. There are chronic inflammatory cells. There is proliferation of Descemet's membrane in some areas onto the anterior surface of the iris.

Ciliary body. The ciliary body shows moderate atrophic changes and some hyalinization. It is detached on one side.

Choroid. The choroid is generally atrophic. There are areas of lymphocytic and plasma-cell infiltration. Chronic passive congestion is present.

Retina. The retina is detached throughout. There is moderate cystic degeneration of the retina anteriorly.

Lens. The contents of the lens have been lost. There is an albuminous exudate on its anterior surface with moderate fibroblastic proliferation on



Figs. 1-5 (Carter). *Fig. 1.* (1936) Narrow wedge of atrophic iris contracture which elongates the pupil in upper nasal quadrant. Narrow rim of sphincter intact.

Fig. 2. (1938) Localized iris atrophy extending from the iris angle in the six-o'clock meridian. Patches of black pigment epithelium. Ectropion uveae.

Fig. 3. (1942) Generalized atrophy nasal half of the iris. Baring of the pigment epithelium more pronounced. Temporal half of the iris comparatively normal.

Fig. 4. (1946) Postoperative filtration bleb on the one-o'clock meridian. Temporal pillar of "normal" iris is the site of iridectomy through trephine opening. Ragged holes have formed in the atrophic iris inferiorly.

Fig. 5. (1950) Filtration bleb flattened by episcleral scar tissue marking the advent of intractible glaucoma. Temporal portion of the iris continues to appear "normal."

* I am indebted to Dr. Windsor Davies for the painstaking preparation and microscopic study of the tissue.

Fig. 6 (Carter). Trephine opening (t) occluded with newly formed fibroplastic proliferation (s). Iris remnant (i) adherent to anterior lip of trephination. Lens capsule (l).

the posterior surface of the capsule. There are fibroblastic proliferation and pigment deposits on the anterior lens surface.

Optic nerve. Due to detachment of the retina, the substance of the optic nerve is drawn forward axially. There is some proliferation of glial tissue in the region of the nervehead.

Discussion

The patient here reported undoubtedly should be placed in the first group of the Henderson-Benedict classification. On the other hand, it would seem to be purely a matter of luck on the part of the observer as to whether his case fell into this group (before the onset of glaucoma) or in the second group (after the onset of glaucoma).

The development of secondary glaucoma, as a complication of essential progressive iris atrophy, occurs with such frequency as to be almost inevitable, although Gold[4] reports a case under observation for over 20 years without evidence of glaucoma.

From the results experienced in this and most other operative cases it would appear that, given a sufficiently long postoperative period of observation, all attempts at decompression, with the probable exception of Friedenwald's cases, are eventually doomed to failure.

Friedenwald[3] (1950) reported two cases in which the intraocular pressure was successfully controlled by postoperative beta radiation. In one instance, with four previous failures, the pressure had been controlled for 11 years after a series of postoperative beta-radiation treatments. Animal experiments demonstrated that beta radiation controlled postoperative episcleral scar tissue formation in test animals. Overproduction of episcleral scar tissue was responsible for the failure of the filtration operations in the untreated controls.

As shown in the microscopic sections in this case (fig. 6), the dense episcleral scarring eventually sealed off the filtrating cicatrix; this probably could have been prevented by postoperative beta radiation. As a preventive measure it is conceivable that radiation treatments over the limbus might reduce the number of dense anterior synechias blocking the chamber angle (fig. 7), thus obviating the need of glaucoma surgery.

The dissolution of the iris whether rapid or extended over a period of years is always baffling in that there is so little evidence re-

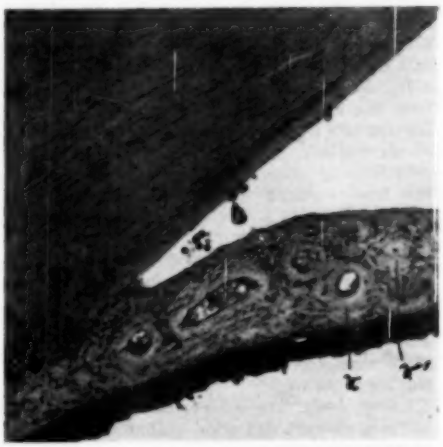


Fig. 7 (Carter). Marked anterior synechia blocking chamber angle (a). Vessel walls (v) thickened. Questionable complete occlusions (v').

maining as to its final disposition. The numerous theories advanced as to its etiology have been fully discussed by de Schweinitz,[2] Rochat and Mulder,[1d] Waite[6] and many others and need not be restated here.

It is apparent that the initial pathologic change is in the peripheral ciliary zone of the iris stroma, including the dilator muscle fibers, thence resolving the underlying pigment epithelium to form holes in the iris with terminal progressive destruction of the sphincter zone. This sequence of events and the distribution of the disease might be expected to suggest some clue as to its pathogenesis.

There are two sharply drawn anatomic zones in the anterior stromal layers of the iris. Their characteristic topographic markings are dependent upon the iris branches of the long posterior ciliary arteries.

The radial branches from the major circle passing through the ciliary zone of the iris give it its meridional striations; the junction of these radial branches in the free anastomosis of the minor circle marks the transition to the narrower more vascular pupillary zone of the iris.

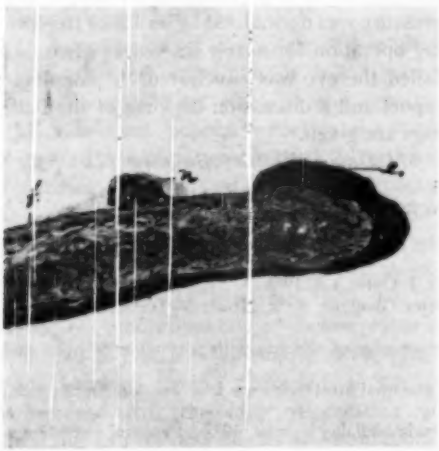


Fig. 8 (Carter). Organized clumps of cells with nodule (n) formations on iris surface. Fibrotic membrane (f) with hyaline staining. Ectropion uveae (e).

Fig. 9 (Carter). Iris (i) extremely thin and atrophic with hole (h) formations. Pigment epithelium (p) blocking angle and plastered on posterior surface of the cornea.

A further point of contrast between the two iris zones, according to Salzmann,[7] is seen in the histology of the two iris muscles. Both are of epithelial origin but, whereas the dilator fibers maintain their epithelial characteristics and appear as spindle-form cells, in the sphincter the transition of the epithelial cell into a muscle cell is complete.

In this latter category, it is interesting to speculate, as did Loewenstein, Foster, and Sledge,[8] on the hypothesis of an aqueous lysozyme acting on the iris through some defect in its epithelial barrier. A preferential proteolytic action on the epithelial dilator fibers could thus account for the primary site of the pathologic process being the ciliary zone of the iris. Proof that some of the earliest pathologic changes are in the anterior layers of the iris is seen in the clump-cell formations and surface hyalinization resulting in an ectropion uveae (fig. 8) over the intact sphincter fibers.

Nutritional atrophy of the iris on the basis of vessel sclerosis or interruption of blood supply (Feingold,[1b] Lane,[9] Waite[11]) provides a most logical conclusion when based

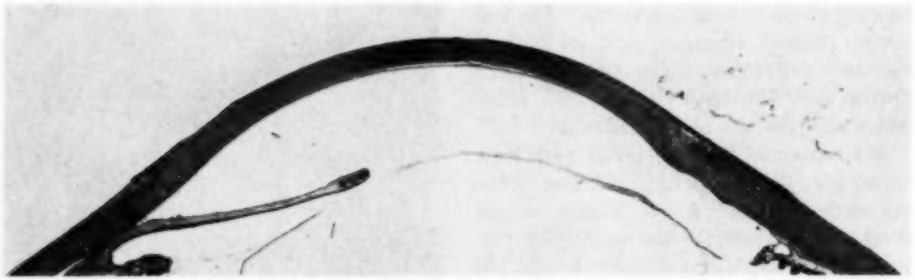


Fig. 10 (Carter). Section through anterior segment showing almost complete iris atrophy on the right (nasally). Higher magnifications are seen in Figures 7, 8, and 9.

on the distribution and the progress of the disease.

The rich vascular anastomoses in the minor circle could very well explain the late involvement of the sphincter portion of the iris. Ellett[1e] (1928) reporting on the pathologic sections in de Schweinitz's case found "complete occlusion" of the iris vessels.

Though the histologic studies in this case (fig. 7) and others (Wood,[1a] Feingold,[1b] Licsko,[1c] Rones[1g]) have shown varying degrees of vessel lumen encroachment short of complete occlusion, it must be remembered that these reports were on iris tissue which managed to survive in a more nearly normal state. In contrast, examination of advanced atrophic areas (fig. 9) reveals a complete absence of vessels as well as all other stromal structures, only disintegrating pigment epithelium remaining.

Who, then, can say that sclerosis with vessel occlusion similar to that occurring in circumscribed choroidal sclerosis has not preceded this melting away of these iris tissues? Animal experimentation, with perhaps the injection of a selective vasosclerosing solution into the root of the iris, may provide informative results from which a more decisive conclusion can be drawn.

Summary

A case of essential progressive atrophy of the iris, which has been under observation for 14 years, is reported. After eight years of noninflammatory, slowly progressive atrophy, secondary glaucoma developed. The pressure was normalized by an Elliot trephining operation for nearly six years; when this failed the eye was enucleated. A pathologic report and a discussion of some of the findings are given.

613 David Whitney Building (26).

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CRITERIA AND GUIDE FOR EVALUATION OF OCULAR PROSTHESES*

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New York

During the past 10 years, there has been considerable activity in the field of socket restoration and preparation, with the result that surgeons are becoming more critical of final prosthetic effects.

The increasing interest in this phase of ophthalmology can be based on several definite factors: (1) The advent of nontoxic plastic compounds; (2) the second world war which saw the final development of the plastic eye; (3) the war gave a large number of ophthalmologists the opportunity to work directly with many eye socket restorations; (4) introduction of the integrated implant by Ruedemann and Cutler with the subsequent abundance of research and reports; (5) numerous popular articles on plastic eyes and extensive commercial advertising regarding personal attractiveness, making the individual more critical of his appearance.

The purpose of this paper is not to explain how artificial eyes are made, nor to advocate certain methods of socket preparation, but to give a brief outline of the problems involved in the fitting of an ocular prosthesis with the idea of creating an awareness of its possibilities and limitations. Such information should prove to be of value to the physician in appraising a prosthetic result, allowing him to check more closely on the work of the prosthetist who will be grateful for any considered criticism.

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The acceptable prosthesis

There are various reasons why a patient should wear an artificial eye other than for cosmetic effect. As listed by Prince[1] an artificial eye, when properly fitted, (a) retains the shape of the socket, preventing collapse of the fornices and loss of shape of the lids. This in turn (b) provides proper muscular action of the lids; (c) helps to retain proper position of the tear ducts; (d) prevents accumulation of fluids in the cavity; (e) protects the socket from foreign bodies; and (f) by all these aids, a prosthesis conserves the normal facial expression since the muscles of the face find their roots near the orbit. Of course, to the patient the cosmetic result is of utmost importance.

A properly fitted and natural-appearing artificial eye is the result of many small details. The omission of one or two fine points may not detract too much from the desired effect but, when possible to include these details, it is only fair to the patient to do so.

Of the various factors involved in a correctly fitted eye each one in itself appears

obvious. But on examining the finished prosthesis, it is not always easy to determine the part at fault since an undesirable effect may be produced by a combination of these factors. However, the following, adopted from Galeski,[2] will be of help in judging acceptability:

1. *The palpebral opening should appear to be the same as in the fellow eye,* showing approximately the same amount of sclera on each side of the cornea. Too much sclera creates a staring effect and stariness cries out for attention. Its avoidance is undoubtedly the first consideration of the prosthetist.

2. *The size and shape of the prosthesis should give the lids the proper curvature and, as a general rule, should allow them to close naturally.*

The eye should fit snugly, but not too tight. If too large, it leads to irritation and discharge, while a small prosthesis induces loss of muscle tone thereby increasing the undesirable effect of a shrunken socket.

3. *The eyes should be properly aligned and in apparent focus when looking straight ahead.* Eyes are fitted only in this one position. Correctness of the focus can quickly be determined by holding a light directly in front of the patient about 14 inches away, creating catoptric images, which must fall on the same parts of the corneas. Lack of complete movement must be compensated for by learning to turn the head in the direction of the gaze.

4. *The iris must be the same size and color* although a slight difference is allowable. But when it is obviously too big or too small, or too far off color, it is not acceptable.

Other details that add to naturalness are: irises are not round but slightly elongated in the horizontal plane; and, corneal opacities, such as small leukomas and arcus senilus, though not of the iris, affect the appearance and should be simulated.

5. *The sclera, like the iris, should be the same in value and color.* It must be said that it cannot be made to match perfectly in all kinds of light. The artificial sclera does not reflect light the same as the human eye. In various half-lights it will appear as a different tone because it is deeper set, because of its probable difference in curvature, and because it is not living tissue.

A fluorescent acrylic is on the market, though, which is believed to be more lifelike and should be an aid to the solution of this problem.

The sclera does not have a smooth, uninterrupted surface but is broken by fine striations or ripples that run radially or concentrically to the limbus. This is more noticeable in older people. The veining, if not sufficient, is a definite mark of artificiality. Pterygia and pinguecula should also be indicated, not to the same extent as in the good eye, but enough to keep from being too obviously different.

6. *The pupil should conform in size, location, and color.* Since the pupil of an artificial eye is fixed, it is difficult at times to judge just how large to make it. However, the accepted rule is to have the fixed pupil slightly larger than the good one appears in a light room. Dark eyes present no problem but, in very light eyes, the inflexible pupil is often the one mark of artificiality in an otherwise excellent prosthesis.

If the good eye has an iridectomy, or appreciably eccentric pupil, the artificial eye will appear more natural if the result is a compromise between a perfect pupil and the live eye. A perfect pupil is in too much contrast with the fellow pupil, while two odd-shaped pupils would appear grotesque (fig. 1).

Some pupils, particularly those of older people, have a definite bluish or greenish tinge. To match this is another small point that makes the prosthesis appear more natural.

7. *The patient should be comfortable and feel better with than without the prosthesis.*

These requirements apply to all prostheses, whether for the ordinary shell and reform eye or for the many types of integrated artificial eyes.

THE ARTIFICIAL EYE

From these criteria just mentioned it follows that a consideration of the type of replacement used would be of importance.

In meeting these requirements the prosthetist will have used either a stock eye (ready made) of glass or plastic, or a custom-made prosthesis of the same materials.

Prior to World War II glass eyes were practically the only ones available. Since skilled eye makers were to be found in only a few of the larger cities, the great majority of users wore stock eyes. This is true today, too, except that now there are stock eyes of plastic.

In cities of average size, the leading optician may be the only one carrying a supply of stock eyes for local and nearby patients, and discerning patients often have to travel a great distance to get a satisfactory replacement. Patients in outlying districts rely on the periodic visits of technicians whose visits are announced beforehand.

In a normal well-healed socket the stock eye of glass is often satisfactory. However, it isn't too difficult to imagine how exceptional it must be to obtain a ready-made eye that matches, even closely, all the sizes, shapes, and colors that fulfill the requirements. And when there is some deviation from the normal, only a conscientious and highly skilled technician can give satisfaction.

Since stock eyes are now available in plastic, service to patients in smaller towns is constantly improving. After the all-plastic eye was developed and proven successful, various companies began work on mass production and have now reached a point where most dispensers are well supplied.

Some of these companies also undertake to give select technicians a course in fitting. The Army, as well, has trained men for this work thus increasing the number of capable ocular prosthetists. This increase in prosthetic service could only be done since the advent of the plastic eye, as it takes from five to 10 years to become proficient at making glass eyes.*

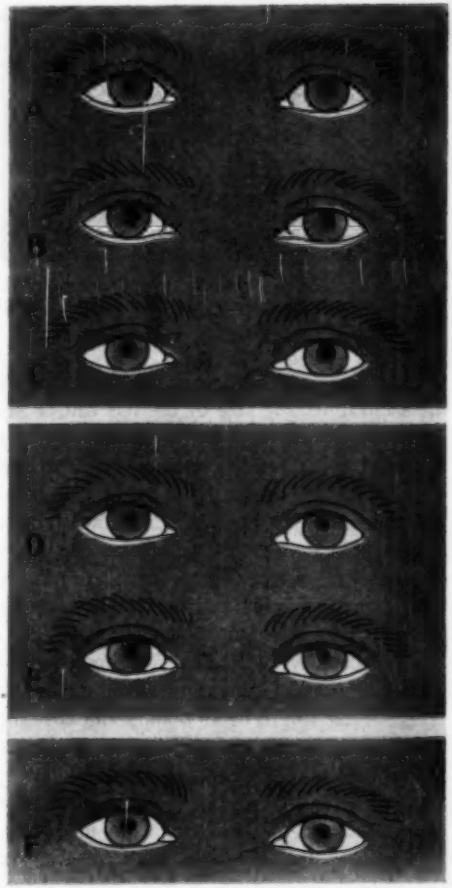

Fig. 1 (Bethke). Diagram to show the cosmetic effect of pupils. (Right eye represents the artificial eye.) (A) The usual round pupil contrasts too much with an iridectomy. (B) The weird result of duplicating a defect. (C) A compromise pupil, somewhat large and above center. (D) Unnatural appearance with a centered pupil. (E) Pupil placed off center. (F) Effect of pupils of different value.

The stock eye of plastic has the advantage of being more durable than glass; in addi-

* Opinion varies as to length of time required to master glass-eye making. I was informed by an officer in one of the largest companies that the art of making glass artificial eyes was gradually dying out in this country due to lack of sufficient apprentices.

Fig. 2 (Bethke). A small anophthalmic socket, due to excessive shrinking of orbital tissue. (Patient of Dr. A. B. Reese.)

tion, it can be ground down and reshaped to fit accurately; the size of the iris can be altered and the color of the sclera and iris changed for a better match. If the eye has to be enlarged, it can be built up with wax to the desired size and shape and then recast. This can be done by the technician or sent to the company supplying the eyes. In a stock glass eye, the color and size of the iris or sclera cannot be changed.

The glass eye will always be popular due to its apparent initial low cost, the stock eyes selling for 10 or 15 dollars and custom-made eyes, which only take about an hour and a half to make, average 35 to 40 dollars. As a stock glass eye is dispensed as a finished article, it can be low in price.

The fact that a stock eye of plastic can be altered necessitates a price range determined by the amount of technical work involved. A safe average to quote a patient would be approximately 50 dollars for the stock eye, and 75 to 125 dollars for the custom eyes.

As to how long after enucleation an eye should be fitted, varies with individuals. It would generally be agreed best for both prosthetist and patient to wait until the discharge has disappeared and the socket looks healthy and clear, approximately four to six weeks.

Insertion of a conformer or a plain shell at the time of operation, or shortly thereafter, is of great help in preparing the socket for an eye. By giving support to the lids and to the fornices, shape is given the socket while healing. The patient automatically becomes adjusted to the prosthesis and a full-sized eye, though not necessarily the final one, can usually be worn at once.

Conformers are nominal in cost and can be obtained from any company dealing in artificial eyes. Their use is advisable when possible and will be appreciated by the prosthetist.

Conditions limiting desirable results

Due to the variability of anophthalmic sockets, it is not always possible to obtain desirable results. However, many of the difficulties can be overcome to a point where the appearance is considerably improved.

In making a satisfactory artificial eye, and especially those for irregular sockets, two facts must be kept in mind: (1) There is always a compromise to be made, (2) the final result will be one that is based on the judgment and ingenuity of the prosthetist.

The following are the most common types of socket irregularities involving problems:

1. Excessive shrinking of orbital tissues.
2. Retraction of upper lid sulcus.
3. Ptosis.
4. Chemosis of conjunctiva.
5. Loss of upper fornix.
6. Orbital cellulitis and marked edema of lids.
7. Sagging of lower lid.
8. Obliterated lower fornix.
9. Displaced implant.
10. Adhesions.

Excessive shrinking of orbital tissues. Shrinking of the socket, which always occurs after enucleation, varies greatly with individuals. The reasons for this shrinkage, described in a paper by DeVoe,[3] are not definitely known but the most probable is the atrophy of orbital fat; while another factor is the tendency of the levator muscle, through lack of support, to pull downward and back.

The result of excessive shrinkage is most noticeable by the deep-set effect of the

socket. An unusually small eye is the best that can be expected in these cases (fig. 2). To overcome this resulting unevenness, glasses with a plus lens to enlarge the appearance of the artificial eye can be prescribed. It will then appear the same as the fellow eye (fig. 3).

Change in the tissues causing changes in the orbital shape is one of the most obstinate factors in artificial-eye work, for it is impossible to judge just how the socket will react. Many times the reaction persists longer than the usual term of four to six weeks. The wearing of a "temporary eye" or a conformer is a great help to the eye maker over this period.

Retraction of upper lid sulcus. This cosmetic blemish, which deeply disturbs many patients and is associated with excessive orbital shrinkage, is the one encountered most frequently (fig. 4). For its correction an anatomic prosthesis[4] has been proposed which is said to fill out the upper lid and "restores the muscular portion to its former position."

From my experience the amount of correction obtainable depends on the tonicity of the lower lid which is practically the sole support of the prosthesis. Building up the superior part of the prosthesis obviously creates a downward pressure that, in time, can cause the lower lid to sag and at the same time forces the iris out of alignment. Though not successful in all cases, such an "anatomic" prosthesis should be tried.

Fig. 3 (Bethke). Plus lens over artificial eye shown in Figure 2.

Fig. 4 (Bethke). A typical deep upper-lid sulcus.

Correction of retraction of the upper lid has been tried surgically by use of spherical implants in the socket, if none was used at the time of operation. Also implants of cartilage, shaped acrylic, dermal grafts, and fascia lata were placed under the skin at the orbital margin.[3]

Ptosis. Anophthalmic sockets, with the added complication of ptosis, lend themselves to various degrees of correction. The raising of the lid by means of a prosthesis is affected in relation to the degree and cause of the ptosis.

Generally speaking, the cases can be divided into two groups. A ptosis which may be the result of edema or trauma from the enucleation usually corrects itself with a well-fitted prosthesis after a period of time.

A ptosis of long standing is, however, more difficult to correct.[5] Some cases in this group lend themselves to little or no correction, while others can be corrected considerably, depending on the ingenuity and persistence of the prosthetist.

Chemosis of conjunctiva. Occasionally after an enucleation, the conjunctiva remains inflamed and swollen for a period of time longer than most patients are willing to wait for a prosthesis. If the swelling persists, it is advisable to proceed with the artificial eye, not only to satisfy the patient but to help give some form to the socket.

These cases are rather difficult to fit. Since the swelling has been observed to affect the inferior portion of the socket to a greater degree, the prosthesis will have to be a combination of the shell and reform

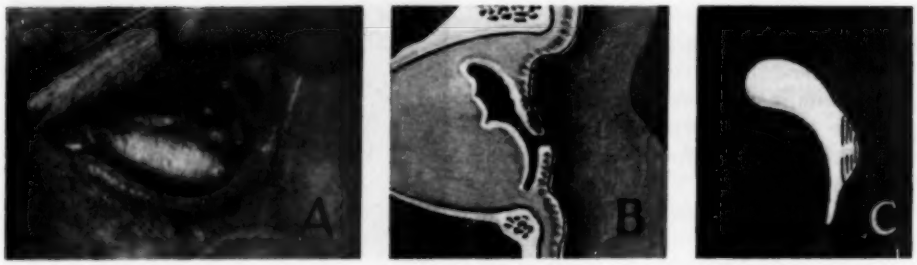

Fig. 5 (Bethke). (A) Conjunctival swelling in inferior portion of an anophthalmic socket. (B) Diagrammatic cross section of (A). (C) Cross section of shape of artificial eye used in socket (A).

types of artificial eye (fig. 5). An ordinary-shaped eye tends to fall back and results in an upward gaze (fig. 6).

The swelling is annoying to the prosthetist in that it increases and subsides in an unpredictable manner. Thus a patient may leave the office with a satisfactory result and a few days later report that the eye is too small. After correction, a worried call reports that the eye is now too big, causing a stary effect. It will be more reassuring to the patient if the surgeon explains the condition to him to dispel his natural feeling that the prosthetist is at fault.

Fig. 6 (Bethke). When an ordinary reform eye is used in a socket similar to that shown in Figure 5-A, an upward gaze is the usual result. Note that round, centered pupil in artificial eye exaggerates iridectomy of good eye.

The plastic eye is a distinct advantage in these cases as it can be enlarged or made smaller as necessary, saving the patient the expense of purchasing several new eyes.

Severe edema of the lids. Postoperative swelling of conjunctiva and lids is not at all uncommon and it usually subsides within four to six weeks. In cases in which marked edema persists (sometimes for months), about the only thing that can be done is to insert a well-fitted conformer and have the patient return for periodic examinations (fig. 7). As the swelling subsides, a larger

Fig. 7. (Bethke). Severe swelling of lids following enucleation. (In this case, the conformer the patient is wearing did not affect the opening of the lids.) (Patient of Dr. John H. Dunnington.)

Fig. 8 (Bethke). Same patient as in Figure 7 one year later. (Patient is wearing a temporary eye.)

conformer is worn until such a time when the lids are open enough for a regular prosthesis (fig. 8).

Loss of upper fornix. This defect which gives the appearance of a shortened upper lid may be a postradiation effect or the result of operative trauma during socket restoration. A good cosmetic result from a stock glass eye is rarely obtained in these cases.

Even to have an eye especially made always taxes the ingenuity of the prosthetist for the tendency of the short taut upper lid is to pull the eye backward, creating an upward gaze. This tendency in turn creates an excessive palpebral opening making two defects to be overcome (fig. 9).

Sagging of lower lid. The main reason for this unfortunate condition is due to loss of muscle tone, through injury or because of age. Since the lower lid is nearly always the sole support of the prosthesis, in a weakened state it permits the eye to drop out of alignment and in most cases also allows more sclera to be shown on the temporal side, thus creating the most obvious artificial-look, stariness (fig. 10).

The prosthetist tries to overcome this by seeking more support from the inner and outer canthal region, or from another part of the lid, usually near the nose, removing downward pressure from the lax temporal portion. The patient is then advised to message the lid with gentle outward and upward strokes. This is not effective in all cases but it is definitely worth the patient's effort to try. If the condition is too severe, it should be corrected surgically.

Obliterated lower fornix. In these cases, it is seldom that an artificial eye can be held in place and surgery seems to be the only method of creating a sulcus in the lower lid. However, if there is any sulcus at all in

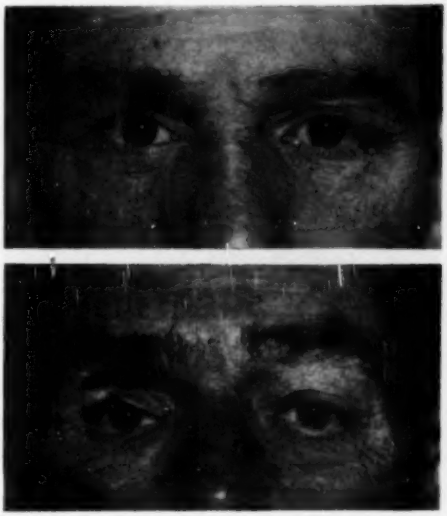

Fig. 9 (Bethke). Two cases of shallow upper fornices of right socket, showing how the temporal margin of upper lid turns out, directing the eyelashes upward. (Patients of Dr. A. G. DeVoe and Dr. Frank Carroll.)

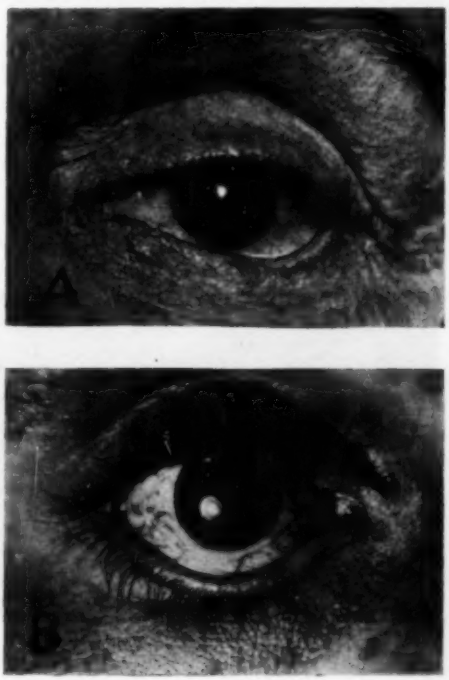

Fig. 10 (Bethke). Anophthalmic sockets with weak lower lids. (A) Temporal portion of lid weakened. (B) Entire lower lid lacking in muscle tone.

Fig. 11 (Bethke). Implant displaced temporally.

which the prosthesis may be placed it is possible at times to devise a conformer, a combination of shell and reform types, that will help to reform the fornix.

The socket should be checked every few months, enlarging the inferior portion of the prosthesis, creating a deeper and deeper sulcus to support the eye. This procedure requires time and patience. If surgery has to be resorted to, a new fornix can be formed by using a buccal mucous graft.

Displaced implant. The displacement of an implant creates a bulging round form that invariably fills the entire socket, making the alignment of the artificial eye the chief problem. A prosthesis must be modelled to contain this form to keep the eye from protruding and, at the same time, to prevent the implant from further displacement. Although most difficult to correct cosmetically, this condition gives excellent movement to the eye (fig. 11).

Adhesions. A socket disfigured by adhesions, whatever the cause, seldom holds an artificial eye that is not especially made for it. These adhesions are usually very tense, do not give to pressure and hence tend to push outward. To fit an artificial eye in these cases, vaults or channels are cut in the prosthesis avoiding contact with adhesions (fig. 12). If the adhesions are such that they allow no support for the prosthesis, the physician must then resort to surgery.

Causes of socket discomfort and irritation

Eye sockets vary greatly in sensitivity in as much as some patients can literally tolerate anything while others react promptly to the slightest pressure or irritation. In the majority of cases, the discomfort is due directly to the prosthesis. Briefly, the trouble can usually be traced to one or more of the following conditions:

1. *A glass eye worn too long.* The average life of a glass eye is about two years, although some patients need a change every year while others wear the eye for five years or more.

Discoloration of the sclerotic is the telltale sign that indicates the need of a new

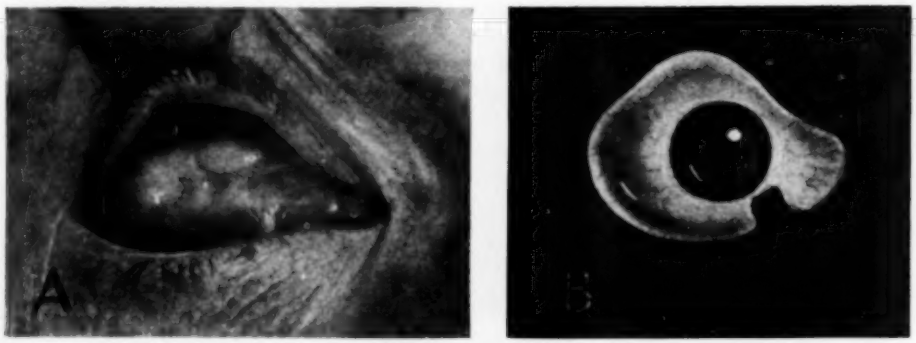

Fig. 12 (Bethke). A socket with a single adhesion of the lower lid (A). (B) Prosthesis with a channel cut to go over the adhesion.

eye, not only for cosmetic reasons, but because a microscopic examination will reveal minute etchings as the cause of the roughened surface. This effect, which is due to orbital fluids reacting on the glass, increases with prolonged usage. It is this emerylike surface that irritates the tender orbital tissue and, if not corrected, may in time develop into more serious complications.

2. *Improperly polished plastic eye.* Fortunately, plastic eyes are not subject to roughening by orbital secretions. In their manufacture and fitting, however, they must be flawlessly polished. The fitting of plastic eyes from stock requires grinding down to the desired shape and then repolishing. Technicians have been known to be lax in this phase of their work, leaving the eyes so rough as to cause a great deal of irritation. I was told by an eye maker, who travels through the smaller towns dispensing eyes, that a great deal of this poor workmanship was encountered, especially in some southern districts. In these cases the physician could act as a check against such abuses, demanding better work for his patients.

3. *Intraorbital pressure.* This is caused either by the prosthesis being made too large, or by orbital swelling after an eye was made. In the desire to make the artificial eye as life-size as possible, the prosthetist is apt to make it a bit too large, even though the final result fulfills all the requirements, such as allowing the lids to close naturally and easily. The patient may be happy with the result for a while but eventually it will cause discomfort accompanied by excessive secretion.

An artificial eye that is too small is a source of annoyance to the patient in that fluids collect in the socket, causing a continuous discharge. If a better fitting prosthesis is not obtained by the patient, the tissues will become irritated, causing not only considerable discomfort but disfigurement through lack of muscular support.

4. *Foreign body.* The drainage system of an anophthalmic socket should be such that tiny foreign particles can be expelled. But foreign bodies may be embedded in the tissues of these sockets just as in normal ones and the fact should not be overlooked when seeking a cause for socket irritation.

5. *Infection.* When prolonged inflammation and swelling cannot be traced to the usual causes, cultures of the socket should be taken to determine the presence of infection.[6] If bacilli are found, the proper antiseptic is prescribed.

During treatment, the healing will be aided by having the patient go without his prosthesis until the socket is free of infection. When the patient is unwilling to do this, as most of them are, suggest leaving the socket free as much as possible. It should be explained to the patient that laxness in personal hygiene may be the cause of the infection.

6. *Allergy.* In a study of 120 cases of inflammation of the orbital socket, Macivor[6] found six cases that were allergic to plastic artificial eyes. Gill[7] found that a "surprising number of persons" were unable to tolerate plastic eyes and reported that the symptoms of abundant discharge and conjunctival edema and swelling disappeared upon substitiuting glass for the plastic eyes.

From these reports it would appear that contact allergy was not uncommon. However, no cases of allergy were found in the experience of prosthetist Grossberg.[8] Alton[5] reports only one case of suspected allergy. I have had two cases of suspected allergy; in one, the symptoms cleared up on changing to a glass eye, and the other found some relief from a glass eye but the discomfort and symptoms remained in a lesser degree. On the other hand, several patients found relief in changing from a glass eye to one of plastic.

Although the symptoms of contact allergy are not as yet too clearly defined, allergy is a factor that should be considered along with the other causes of socket discomfort.

Whenever it is suspected, as when persistence of irritation does not clear up by other means, it is thought well to advise a change in the type of prosthesis.

Advice to the patient

Although the prosthetist gives general instructions and advice to the new user of an artificial eye, the patient will usually want a confirmation from the physician.

The patient must be reminded of a few simple rules of hygiene: (1) To wash the hands well before inserting or taking out his prosthesis; (2) to keep the socket clean and healthy by rinsing out as needed with a solution of saline or boric acid (or whatever the physician thinks best); (3) to cleanse the prosthesis with soapy fingers only, and specifically to avoid the use of solvents.

For a plastic eye that is regularly taken out I recommend cleansing and polishing every two months or so with a creamy paste made of whiting and water. This removes any slight abrasions that might occur in the plastic.

The patient invariably asks if the eye should be taken out at night. Opinions vary about this but the consensus is that, if the lids close normally and the eye is comfortable, it can be worn all the time. Sockets that have held an eye continuously for long periods have been observed to be in a good healthy condition.

If the eyelids do not quite close or there is any discomfort at the end of the day, it is advisable to remove the prosthesis because of the drying tears and mucous that might accumulate. Although glass eyes are ordinarily taken out at night solely to prolong their life, some physicians believe it better that the orbital tissues have a chance to rest during this period.

Patients with the ordinary, loose type of artificial eye must be told to avoid extreme eye movements and to look straight at people when talking to them since the movement of a prosthesis is very limited. This is done by learning to turn the head instead of the eyes. It keeps the attention away from the artificial eye which would otherwise attract attention to it.

The patient should be warned about the changing condition of the socket, especially during the first year after enucleation, and be advised to keep close check on the artificial eye. If the eye becomes too small for the socket to such an extent that he is aware of it, an adjustment is necessary.

Lastly, it will give considerable assurance to the wearer of a new eye to be told that, by being natural and forgetting his affliction as soon as possible, his trouble will be much less noticeable. The majority of artificial eyes do go unobserved and it is very comforting to these patients to know this.

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A SIMPLE AFTER-IMAGE TEST*

Its diagnostic significance in clinical ophthalmology

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This paper originates from a chance observation which I made one evening when I was invited to a friend's home for a music recital. In front of me there was an illuminated lamp with an orange-red lampshade standing on a table covered by a grayish tablecloth. While listening to the music I happened to fix my gaze on the lampshade and then turned my eyes onto the tablecloth below. To my surprise a clear, bluish after-image of the lampshade appeared on the cloth.

This image lasted some 10 seconds, waned and reappeared, only to disappear and reappear again at short intervals. After about two minutes, this exciting phenomenon had faded away but could readily be revived after fixing on the lampshade again. It was not this negative after-image as such but its marked rhythmic fluctuation of intensity which aroused my interest and made me consider the matter more carefully.

It would lead us too far to review here the vast literature on this subject. Nevertheless, it is interesting that these visual phenomena have been known since very early times. Aristotle mentions after-images; they attracted the attention of Newton (1689) and Goethe (1819), and were extensively studied particularly by Purkinje (1819), Plateau (1833), Fechner (1838), and von Helmholtz (1866) during the last century.

While of primary interest to physiologists, after-images were later also investigated by psychologists (Jaensch, 1929: eidetics), psychiatrists, and neurologists (Judd, 1927; Vujic and Loewy, 1939; and others).

Surprisingly little can be found, however, in clinical ophthalmic literature, although we are dealing with a phenomenon originating in the periphery, depending upon retinoneural processes and not on higher cerebral activities. This can be proved, for instance, by Bidwell's experiment (Duke-Elder, volume 1, page 963) and seems to follow logically from our findings in unilateral ocular diseases affecting the after-images, as will be described.

Usually we divide after-images into two types, according to whether they are of the same nature as the primary stimulus: positive after-images, or, of the opposite nature, negative after-images.

"A single brief stimulus of medium intensity produces a positive after-image but at the same time it tends to inhibit visual processes of a like nature and to encourage those of an opposite kind, so changing the state of the visual mechanism that a second stimulus falling upon the same retinal area becomes modified and gives rise to a negative after-image" (Duke-Elder, volume 1, page 953).

The appearance of negative images is favored by a prolongation of the primary stimulus. If a white object is fixed and then the gaze turned onto a light gray surface, a dark after-image will appear; if the primary stimulus was colored, the complementary color will appear.

Both positive and negative after-images show a tendency to rhythmic variations which may be compared to other rhythmic reactions of the nervous system and may be placed in the category of "periodic reflexes of perception" (Froehlich, 1920-21; Bayer, 1926).

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Method of study

I thought it might be worth while to investigate the behavior of the easily observable negative after-images in various eye diseases. For this purpose it was necessary to examine first a great number of normal persons with a well-established and simple test and study the "normal" response.

The test used was worked out empirically and is so simple that anyone can without difficulty make use of it. The necessary equipment includes an ordinary stereoscope and two charts.*

One chart is of light gray cardboard containing two small fixation points at ordinary pupillary distance (one in each field of the stereoscope); this will serve as background (second stimulus—already described).

The second chart has, on one side, two discs, 25 mm. in diameter, made of dark-blue nonreflecting paper (wavelength about 4,380 A.U.) with a white central fixation point at pupillary distance. On the other side it is covered with a black paper on which two red (about 6,650 A.U.) discs of the same size with central, black fixation points are pasted at pupillary distance. These colored discs on the second chart will serve as primary stimulus and will produce a yellow and a bluish-green after-image, respectively.

The stereoscope is not essential but aids a great deal in holding the concentration of the patient during the examination. The charts should be kept at a constant distance from the eye so that the after-images will be of the same size as the primary stimulus (the discs).

The eyes can be conveniently tested together because the two discs are automatically fused, or they may be tested separately by simply covering one eye. The colors and the size of the discs have been chosen so that they will give the clearest and most easily perceptible negative after-image in practically any normal person.

* We can provide the charts but one also can easily make them oneself.

Test procedure

The patient is examined in a dark room but without any special dark adaptation. He holds the stereoscope in his hand while the two charts (the gray background chart behind) are inserted at the distance where they are seen clearly. A moveable skiascopy lamp with a 75-watt bulb is brought as near as possible to illuminate the chart evenly and the patient is now asked to fix the central point in the colored disc for 50 seconds without moving his eyes.

This long stimulation and the use of pigment colors—not filters—will exclude interference from positive after-images and make the negative after-image appear more clearly. Since it is almost impossible to keep the eyes absolutely still for such a length of time, the examined person will frequently say that he sees the complementary color of the disc appear at its borders even during the time of stimulation.

As a rule, the testing is done first with the red discs and one should let the patient rest for at least three minutes after the bluish-green after-image has disappeared before it is repeated with the blue discs.

After the 50-second exposure, the lamp is moved away to a distance of about 40 cm. (because the after-images will last longer on a less bright background—Juhasz, 1920) and, at the same time, the chart with the colored discs is quickly removed. The patient is now asked to fix the point on the gray background behind and to tell what he sees.

It is admitted that this arrangement of after-image testing is very rough; it will not yield fine differentiations, but it is a satisfactory subjective test for anyone with average intelligence.

Normal response

As a rule the following information can be obtained: After a latent period of one to three seconds, a patient will see a bluish-green shadow of the same size as the orig-

inally fixed red disc around the fixation point on the gray background chart. Its intensity usually increases rapidly, remains stationary for several seconds, and then the shadow disappears completely only to reappear after an interval of five to 10 seconds. This time many patients see it longer than the first time and occasionally more intensely.

After another interval of a few seconds, a third, somewhat fainter, after-image of the same color will appear and be perceptible for about 10 seconds. While gradually becoming fainter, this phenomenon may repeat itself five to 10 times, usually in more rapid succession toward the end. It is rare for any after-images to be seen after 100 seconds.

Sometimes only two to three initial waves are noted, very rarely no rhythmic variations at all are seen but the round bluish shadow fades away gradually. Occasionally a great number of waves in rapid succession, lasting for several minutes up to half an hour, are recorded.

After blue, a bright yellow after-image is seen almost immediately after the chart is removed and usually fades away slowly in 30 to 50 seconds. Occasionally, one or two rhythmic variations are also observed here but, during them, the yellow color does not always disappear completely, as the bluish-green does after the red test object.

Briefly this is the response obtained on binocular testing of more than 100 "normal" persons of average intelligence. Color-blind people (dichromats and anomalous trichromats) will also perceive after-images but these will be of an indefinite hue, will not last as long as in normal persons, and the number of rhythmic variations will be small (Guttmann, 1920).

From these rather varied findings, one concludes that a normal response with this test is one in which an after-image of the complementary color is clearly seen and usually, but not necessarily, shows a rhythmic variation of the type already described.

Practically, during testing, only the number of undulations and the total length of time during which the after-image is seen are noted; the exact duration of each separate wave and the intervals between them were found to vary so much, even in the same individual, that no importance could be attributed to them. I consider the response to be pathologic if it is absent altogether on one side only, or if it is definitely shorter or has less tendency to rhythmic variation on one side as compared with the other.

It goes without saying that, in patients with pathologic eye conditions and for the detection of malingerers for whom the test may also be applied, each eye is examined separately. In the first instance the good eye is tested first so that the patient understands better what he sees normally; in the second instance, the "bad" eye is, for obvious reasons, tested first.

Below are short summaries of some of our observations in various types of fundus disease in which the response to the described after-image test was investigated. The patients here presented were all intelligent and attentive so that their statements can be taken as correct.

Case reports

Disease of the optic nerve

Case 1

History. Willy B., aged 27 years, had blurring of vision in the left eye for one week. There seemed to be no focus of infection; neurologic examination was normal. Vision was: O.D., 1.0; O.S., 0.8. The fundi were normal. In the left eye, there was a relative cecocentral scotoma for red; the perpiheral field was normal.

After-images. (After red): O.D., five waves blue in 50 seconds; O.S., one wave bluish in eight seconds. (After blue): O.D., seven waves in 60 seconds; O.S., three waves in 20 seconds.

Diagnosis. Retrobulbar neuritis of the left eye.

Two weeks later the left eye showed: Vision, 0.9; slight blurring of the disc margin, otherwise normal; cecocentral scotoma unchanged; after-images: red, three waves in 30 seconds; blue, four waves in 30 seconds.

Five weeks later the left eye showed: Vision, 1.0; fundus normal; no more relative central scotoma (Haitz chart); after-images: red, O.D., five waves in 50 seconds; O.S., four waves in 40 seconds (almost normal), blue, O.D. and O.S., seven waves in 65 seconds.

CASE 2

History. Werner von A., aged 28 years, had had papillitis of the right eye for six days. There was a focal infection from a dental granuloma of the upper first premolar tooth on the right side.

Vision was: O.D., 0.1, with a central scotoma of about 15 degrees; O.S., 1.50, other findings normal.

After-images. (After red): O.D., absent; O.S., seven waves in 80 seconds; (after blue): O.D., absent; O.S., gradually fading in 30 seconds.

Ten days later (six days after the removal of the suspected tooth): O.D., Vision, 0.8; papillitis better, borders more clear; after-images as previously charted.

Eight days later: O.D., Vision, 1.25; still no after-images after red; some yellow shadow after blue.

Another week later: O.D., Vision, 1.50; fundus practically normal. After-images: three faint waves after red in 30 seconds and a yellow shadow for 40 seconds after blue.

CASE 3

Ida G., aged 22 years, was suspected of having multiple sclerosis. She had had blurring of vision in the right eye for a few days. In the right eye, vision was 0.9; the fundus showed some hyperemia and blurring of the disc margin. There was a small central scotoma for red on the Haitz chart.

After-images were absent for red and blue.

The left eye showed vision to be 1.0, the fundus normal. After-images: (after red): five waves in 60 seconds; (after blue): three faint waves in 40 seconds.

Diagnosis. Optic neuritis of the right eye.

Two weeks later: O.D., vision still 0.9. After-images after red were two waves in 20 seconds.

Another four weeks later: Vision, O.U., was 1.0 and the central scotoma of the right eye had disappeared. After-images were: (after red): O.D., three waves in 40 seconds; O.S., five waves in 55 seconds; (after blue): O.D. and O.S., three faint waves gradually fading in 30 seconds.

CASE 4

Nelly L., aged 32 years, had retrobulbar neuritis of the right eye, etiology unknown. Later, papillitis was also present. Vision was counting fingers at two meters. There were no after-images.

The left eye was normal with vision of 1.0, and normal after-images: (after red), four waves in 50 seconds; (after blue), two waves in 36 seconds.

Three weeks later vision in the right eye was 0.5, and there still were no after-images.

CASE 5

Marie K., aged 55 years, had papilledema of both eyes, probably due to impaired renal function (N.P.N., 140 mg. percent). There were no retinal or vascular alterations of importance. Vision was: O.D., 0.2; O.S., 0.5.

After-images. (After red): O.D., two faint waves in 28 seconds; O.S., several indistinct waves in 55 seconds. (After blue): O.D., absent; O.S., one short wave in 12 seconds.

CASE 6

Renee P., aged 22 years, had papilledema of the left eye (about two diopters) with acute exudative, probably tuberculotoxic retinitis. Vision in the left eye was 1.0, there was no central scotoma but a slight peripheral contraction of the visual field. The right eye appeared normal with vision of 1.50.

After-images. (After red): O.D., three waves in 55 seconds; O.S., two waves in 40 seconds, somewhat different in color. (After blue): O.D., gradually fading in 30 seconds; O.S., gradually fading in 26 seconds.

CASE 7

Viktor van G., aged 63 years, had hypertension with a blood-pressure reading of 260/140 mm. Hg; and N.P.N., 125 mg. percent. His hypertensive retinopathy with papilledema was more marked on the left. Vision was: O.D., 0.9; O.S., counting fingers at one meter.

After-images. (After red): O.D., three waves in 37 seconds; O.S., absent; (after blue): O.D., four waves in 42 seconds; O.S., absent.

CASE 8

Anton A., aged 46 years, had blurring of vision for six months. He used nicotine excessively. He had toxic amblyopia, O.U., with temporal pallor of the discs and cecocentral scotomas. Vision was: O.D., 0.4; O.S., 0.6.

After-images. (After red): O.D. and O.S., absent. (After blue): O.D. and O.S., gradually fading in 35 seconds.

CASE 9

Hans B., aged 35 years, had had headache for three weeks. There was increased intracranial pressure—280 mm. H_2O. A cerebral tumor was suspected and this suspicion was later confirmed.

Vision was: O.U., 1.0; visual fields were normal; beginning choked discs were seen in both eyes.

After-images. (After red): O.U., 14 waves in 80 seconds. (After blue): O.U., four waves in 85 seconds.

CASE 10

Wilhelm P., aged 32 years, had commotio cerebri with fracture of the skull four weeks previously. Externally the eyes were normal as were the fundi. Vision was: 1.0, O.U. After-images were normal.

CASE 11

Hans T., aged 51 years, had primary optic atrophy (tertiary syphilis) with contracted visual fields, O.U. Vision was: O.D., 0.6; O.S., 0.3. No after-images were present.

GLAUCOMA

CASE 12

Rosa H., aged 56 years, had noncongestive

glaucoma simplex of the left eye for two years. Tension was 35 mm. Hg (Schiøtz); vision was 0.5, with a glaucomatous excavation of the disc with pallor. There were no after-images.

The right eye was normal with vision of 1.0. After-images were normal: two waves in 30 seconds after red and gradually fading in 30 seconds after blue.

CASE 13

Hermann M., aged 62 years, had acute congestive glaucoma of the right eye. It was the first attack and was controlled with miotics. Tension was now 27 mm. Hg. Visual fields and vision were normal. The anterior chamber was shallow and there was some atrophy of the iris. Fundus findings were normal. The left eye was normal. After-images were normal and equal on both sides.

CASE 14

Albertine V., aged 58 years, had early noncongestive glaucoma of the right eye, with tension of 45 mm. Hg. There was no excavation of the disc; a small Seidel scotoma was present. Vision was 1.0.

The left eye was normal with vision of 1.0.

After-images. (After red): O.D. and O.S., three waves in 60 to 65 seconds. (After blue). O.D. and O.S., gradually fading in 35 seconds.

CASE 15

Max E., aged 36 years, had noncongestive glaucoma, O.U., with marked concentric contraction of the visual fields to about 10 degrees. Tension was: 40 mm. Hg (Schiøtz); vision was: O.D., 0.6; O.S., 0.8. Dark adaptation was 1/64 (Birch-Hirschfield). The fundus examination showed deep glaucomatous cupping with beginning atrophy.

After-images. (After red). O.U., one blue wave and then two faint shadows in 30 seconds. (After blue): Gradually fading in 35 seconds.

DISEASES OF THE RETINA AND CHOROID

CASE 16

Willi St., aged 42 years, had a normal right eye with vision of 1.25. The left eye showed chorioretinitis serosa centralis (Kitahard) with a central scotoma and vision of 0.6.

After-images. (After red): O.D., 12 waves in 80 seconds; O.S., one gray wave in 10 seconds. (After blue): O.D., four waves in 50 seconds; O.S., absent.

Four weeks later there was no more edema of the macula of the left eye but several small white dots were present. Vision was 1.0. After-images for the left eye showed: (After red): three waves of grayish green in 30 seconds; (After blue): one white wave in six seconds.

CASE 17

Kurt F., aged 14 years, showed familial pigmentary degeneration of the retina in both eyes. Vision was: O.D., 0.6; O.S., 0.7. There was peripheral contraction of the fields. Dark adaptation was one sixteenth of normal.

After-images. (After red): O.U., three waves in 30 seconds. (After blue): O.U., fading in 25 seconds.

CASE 18

Albert B., aged 28 years, had juvenile macular degeneration (Stargardt) of both eyes, with vision of 0.2.

After-images. (After red): Normal; five waves in 80 seconds. (After blue): Normal; three waves in 40 seconds.

CASE 19

Emma V., aged 35 years, had a mild retinopathia albuminurica with beginning peripapillary edema of both eyes. There was no star figure. Vision was 1.0.

After-images. (After red): O.D. and O.S., three waves in 50 seconds. (After blue): O.D. and O.S., two waves in 30 seconds.

CASE 20

Anna A., aged 54 years, had diabetic retinopathy of both eyes, with vision of: O.D., 0.8; O.S., 0.7. The after-images were normal.

CASE 21

Rosalia B, aged 46 years, had chorioretinitis disseminata of both eyes, more marked on the right. Vision was: O.D., 0.1; O.S., 1.0.

After-images. (After red): O.D., three waves in 25 seconds; O.S., six waves in 58 seconds. (After blue): O.D., gradually fading in 20 seconds; O.S., gradually fading in 30 seconds.

CASE 22

Lydia F., aged 35 years, had chorioretinitis localisata juxtapapillaris with posterior vitreous detachment of the right eye. Vision was O.D., 1.0; O.S., 1.0. Findings in the left eye were normal. After-images for both eyes were normal.

CASE 23

Elsbeth M., aged 22 years, had high myopia (familial) of both eyes (—9.5D. sph. with cylinder). The left eye showed retinal detachment of the lower half with several holes in a degenerative area in the lower temporal periphery. Vision was: O.D., 0.8, corrected; O.S., 2/50, corrected.

After-images. (After red): O.D., three waves in 35 seconds; O.S., one wave (gray) in five seconds. (After blue): O.D., gradually fading in 30 seconds; O.S., white fading in 20 seconds.

CASE 24

Friedrich K., aged 58 years, had melanosarcoma of the choroid in the macular region near the disc, left eye. Vision was 0.4. The right eye was normal with vision of 1.0.

After-images. O.D., normal; O.S., absent.

Histologically, after enucleation, a penetration of the tumor into the optic nerve was demonstrated.

Comment

This short review of some of our cases with various ocular diseases shows that after-images are mainly affected in inflammatory, toxic, or atrophic processes involving the path of conduction of visual sensation (Cases 1, 2, 3, 4, 7, 8, 11, 12, 24); while primarily edematous alterations (Cases 6, 9, 19) have minimal influence.

Diseases of the retina and choroid also do not change after-images in a constant, significant way. Similarly, in glaucoma, after-images are usually normal so long as the nerve has not been damaged by pressure atrophy (cupping of disc in Case 12).

Case 16, a chorioretinitis centralis serosa (Kitahara) appears ophthalmoscopically as a case of a superficial edematous process. From the behavior of the after-images, we may assume that a toxic factor damaging the conducting pathway was present in this case. Degenerative, deep central retinal lesions (Case 17), on the other hand, had normal after-images.

One observation seems to be of particular importance. In those diseases of the optic pathway in which the after-images have been affected (see Cases 1, 2, and 3), the after-images return to normal more slowly than the vision and other usually tested functions, such as color sense and visual field changes. Here we are apparently testing a different or more subtle function of the conducting pathway.

We may also assume that this function, being the last to recover, is also the first to be affected in diseases of this path. But how is one to prove this assumption, since we rarely are in a position to see an optic-nerve affection at such an early stage and diagnose it as such?

Among the many patients examined with this test there was one whose findings would support this idea:

Case 25

Josef K., aged 20 years, has been known for two years to have multiple sclerosis. He came to the clinic for a regular check-up examination of the fundus. He has had no complaints related to the eyes. Vision, O.U., is 1.25. The fundus is normal. Visual fields and the color sense are good. There is no central scotoma for colors (Haitz chart). There is horizontal nystagmus on lateral gaze.

After-images. (After red): O.D., six waves in 70 seconds; O.S., only one short dark shadow. (After blue): O.D. and O.S., gradually fading in 28 seconds.

Five days later the patient came back with complaints of blurring of vision on the left. Vision was: O.S., 0.4., with the fundus normal. There was a relative central scotoma for white. After-images were absent altogether. The right eye was as found at the previous examination.

The diagnosis of retrobulbar neuritis was evident; the alterations of the after-images had preceded the appearance of the other symptoms by several days.

This is only a single observation but, together with the other findings with this after-image test, it seems highly significant.

The fact that unilateral lesions are associated with a pathologic response of the after-images is considered as another proof for the peripheral origin of these visual phenomena.

On the basis of these findings, the after-image test, as described in the text, is suggested as a complementary and very subtle diagnostic aid in affections of the conducting path of visual sensation, in particular of the optic nerve in its retrobulbar course.

Summary

Described is a simple clinical method for the testing of negative after-images which appear in all normal persons after having fixed a brightly illuminated colored disc in the stereoscope. Usually these after-images show definite rhythmic variations in intensity.

Examination with this test was performed in a great number of patients with intraocular affections and diseases of the optic nerve. In the latter, it was found that after-images might be absent or markedly changed before noticeable deterioration of vision, or changes in the visual field and color sense. On the other hand, they return to normal only after the other tested functions. Ap-

parently, a more subtle function of the conducting path of visual sensation is tested by this method.

This suggests the use of the after-image test as a valuable complementary aid in the diagnosis of optic-nerve affections, in particular those retrobulbar in type.

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HEREDITARY HEMORRHAGIC TELANGIECTASIA

Report of a case

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Hereditary hemorrhagic telangiectasia is a vascular anomaly, characterized clinically by hemorrhages and anatomically by multiple dilatations of capillaries and venules.

This condition was probably described by Fordyce in 1784, though the first recognition of this disease was apparently by Sutton in 1864. The condition then received the attention of Rendu (1890), Osler (1901), and Weber (1907), and was called Rendu-Osler-Weber's disease.

Frederick Hanes reviewed the literature in 1909, and suggested the name hereditary hemorrhagic telangiectasia. It is also known as Goldstein's heredofamilial angiomatosis, after H. I. Goldstein, who has written much on the subject and who published a comprehensive review of the literature in 1931.

The disease is not uncommon. More than 175 families, involving over 1,000 individuals, have been found in the literature.

This vascular anomaly appears to be transmitted as a single dominant by both sexes. The sexes are equally affected. It rarely affects more than six generations, and fortunately becomes relatively milder in succeeding generations. Some families appear to show "skips" in the genealogy. This may be true atavism or it may be that the persons were symptom free, or that the telangiectases were in the viscera and not diagnosed.

Diagnosis

The diagnosis is based on the triad of hemorrhages, multiple telangiectases, and familial history. The telangiectases may be found in childhood, but usually appear with the second decade and increase as age advances.

The individual telangiectases may be pinpoint in size, or large. The individual lesions

fade on pressure (viewed through a slide) and their capillary network can be seen with a magnifying glass.

The lesions may cause little or no trouble. Usually, though, as the patient ages, the spots become more prominent, and the bleeding increases. In typical cases, the bright red, violaceous, or purple lesions may be seen on the face, lips, tongue, conjunctiva, ears, finger-tips and even the feet.

They have been found in the esophagus, in the stomach with the gastroscope, and at autopsy in the pharynx, larynx, trachea, lungs, and duodenum. One case of multiple aneurysm of the splenic arteries was described. Both the spleen and liver have been found enlarged. The symptoms are those of hemorrhage and anemia.

Epistaxis is especially common, but bleeding may come from the tongue, mucous membranes, gastro-intestinal, respiratory, or genito-urinary tracts. Hemorrhages into the brain and retinas have been described. The blood findings are normal, unless anemia is present from acute or chronic hemorrhages.

Epistaxis is usually the first hemorrhagic symptom, and occurs when the individual is in the later teens and twenties. Hematemesis, hemoptysis, hematuria, and so forth, occur in the fourth decade.

Death from hemorrhage is infrequent. In fact, Boston has pointed out that these patients recover surprisingly rapidly from intensive hemorrhage. However, in spite of the rapid recovery, a state of semi-invalidism is common.

Pathology

Pathologically, the lesion usually shows an increased number of dilated vessels. Although there may be dilatations of the capillaries and venules which have no deficiency of elastic tissue, usually the walls of the involved vessels are extremely thin, consisting of a single wall of endothelium and permitting hemorrhages to occur from trivial causes. The groups of dilated vessels are not permanent, but vary from time to time in number, size, and tendency to bleed, even to the point of disappearing entirely, probably due to thrombosis, which is frequent.

Treatment

Treatment consists of the usual steps to stop actual bleeding: cautery, pressure, X-ray irradiations, snake venom, rutin—none have been wholly successful.

Eye involvement

Eleven cases involving the palpebral conjunctiva have been described: Weber (1907), Nones, five cases (1909), Schwartz (1925), Schoen (1930), Stock, two cases (1944), and Reed (1948). However, none of these were reported in the ophthalmic literature. The following case is reported for that reason.

Report of a case

The patient, Dr. L. A. E., aged 42 years, of Syrian, French, English ancestry, was first seen in June, 1947, because of presbyopia. At that time, nothing remarkable was noted on examination. He was again seen in April, 1949, because of stinging and burning and tearing of his eyes. He stated that his lids felt "sticky," and that he had some photophobia.

The bulbar conjunctiva in each eye was white; however, beneath the lower lid of the left eye were several minute red hemorrhagiclike spots. Under the upper lid of the left eye were several larger spots, about twice the size of a pinhead. These pushed the conjunctiva upward, forming a plaquelike mass (fig. 1). Similar spots were present on the conjunctiva of the right eye (fig. 2) and on the membranes of the lips and tongue (fig. 3).

Past illness. This patient has had nosebleeds all of his life. At times, these are quite severe. They are exaggerated by head colds, but at all times there is some blood blown from the nostrils.

Three years previously, he developed a bleeding sore on the tip of the tongue that was controlled only after cauterization. About two years previous, he began having recurrent hemorrhages from the right lower lid; fortunately this was easily controlled.

Bleeding from the lower lip has occurred at irregular intervals during the past three years. Alcohol, taken even in moderate amounts, will invariably result in bleeding from one of the points mentioned. He had had the usual childhood diseases, a tonsilectomy at the age of seven years, and recurrent influenza.

Family history. His maternal grandfather

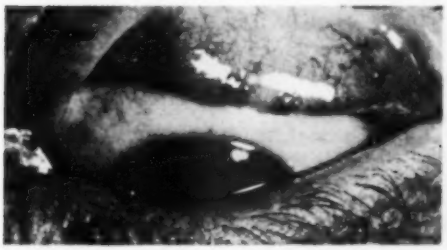

Fig. 1 (Miles). Under the upper lid of the left eye were several large spots.

had nosebleeds all of his life. He also had red spots over his lips, tongue, in the mouth, nose, and on lobes of ears. This man died at the age of 76 years with heart disease.

His mother, aged 62 years, has red spots on her lips, in the nose, and on the roof of her mouth. She is subject to frequent and, occasionally, severe nosebleeds. She also has hemorrhages from the roof of her mouth.

Two maternal uncles were subject to nosebleeds all their lives. Both had red spots on their mucous membranes. Both died at the age of 52 years from nephritis and hypertension.

Two first cousins, daughters of these uncles, are subject to nosebleeds and have involvement of their mucous membranes.

Five other children of the same two uncles are apparently symptom-free.

One daughter, aged 19 years, has frequent nosebleeds and has recently been bleeding from a single red spot on her gums.*

Fig. 2 (Miles). Similar spots were present on the conjunctiva of the right eye.

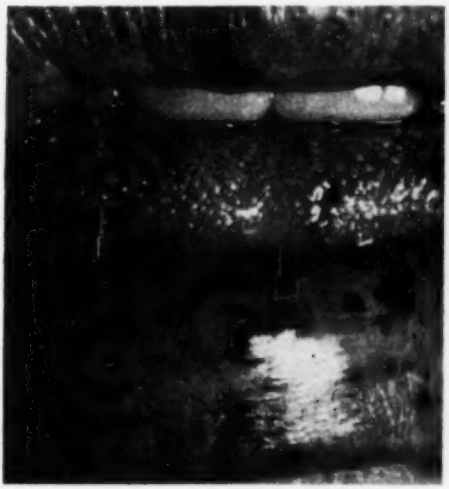

Fig. 3 (Miles). Spots on the membranes of the lips and tongue.

* A diagnosis of pyorrhea was made and this girl was referred to a peridontist who stated that she had no pyorrhea, but that he could not make a diagnosis. Conversations with several other dentists revealed that their literature is as bare of this disease as is our ophthalmic.

One daughter, aged 17 years, is at present symptom free.

Pathologic report

Dr. A. E. Casey, Highland Baptist Hospital, reported:

Microscopic examination. Biopsy of the eyelid shows dilated and cavernous blood spaces situated in the papillary layer of the tunica propria. These contain a few red blood cells.

Pathologic diagnosis. Conjunctiva—congenital familial cavernous hemangiectasis. Lip—congenital familial cavernous hemangiectasis, mucous membrane.

Laboratory report

Blood studies were done by the patient in his office, and reported as negative. The exact figures were not obtained.

Summary

Hereditary hemorrhagic telangiectasia has been reviewed, and a case is reported. This series has involved four generations and is apparently becoming milder in succeeding generations. Insofar as information could be obtained, no members died of hemorrhages. Though the patient is a physician, and his father before him was a physician, no medication which they tried has been of any value.

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OCULAR SARCOIDOSIS*

Report of three cases

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Review

Schaumann,[1] in 1914, showed that the lesions of the nose, ears, and fingers described by Besnier[2] in 1889, as lupus pernio, and the disease affecting the skin, mucous membranes, lymph nodes, lungs, bones, and internal organs which Boeck,[3] in 1889, termed sarcoid, are the same.

Kuznitsky and Bittorf,[4] in 1915, directed attention to the pulmonary lesions. Jüngling,[5] in 1919, described the bone lesions of this disease under the term "osteitis tuberculosa multiplex cystica."

It was not until 1936 that it was realized that the eye lesions described by Heerfordt,[6] in 1909, as "febris uveo-parotida subchronica" were part of the general clinical picture of sarcoidosis. It was Schaumann who directed attention to the fact that this disease is one in which a diversity of organs are involved.

During the period from 1914 to 1937 the disease was described under many different names. Longcope[7] and his associates published the first article, with a sizable series of cases, in which it was realized that a multiplicity of organs were involved, and that there were numerous and varied clinical aspects of the disease. He and his associates pioneered the present concept of sarcoidosis.

The classical concept of the disease is best expressed in a definition of sarcoidosis[8] by the conference on sarcoid, National Research Council, February, 1948, as follows:

"Sarcoidosis is a disease of unknown etiology. Pathologically it is characterized by the presence in any organ or tissue of epithelioid-cell tubercles with inconspicuous or no necrosis, and by the frequent presence of refractile or apparently calcified bodies in the giant cells of the tubercles. The characteristic lesions may be replaced by fibrosis, hyalinization, or both.

"Clinically, the lesions may be widely disseminated. The tissues most frequently involved are the lymph nodes, lungs, skin, eyes, and bones, particularly of the extremities. The clinical course is usually chronic, with minimal or no constitutional symptoms; however, there may be acute phases characterized by a general reaction with malaise and fever. There may be signs and symptoms referable to the tissues and organs involved. The intracutaneous tuberculin test is frequently negative; the plasma globulins are often increased. The outcome may be clinical recovery, with radiographic evidence of residue, or impairment of function of organs involved, or a continual course of the chronic disease."

Present study

It is not within the scope of this paper to deal with all the phases of the disease. Extensive reviews of the literature are found in the articles of Schaumann, Longcope, Piner,[9] Hunter,[10] and Snapper,[11] Harrell,[12] Katz, Cahe, and Reed,[13] Reisner,[14] Freiman,[15] Ricker and Clark,[8] Michael, Cole, Beeson, and Olson.[16]

It is the purpose of this paper to present a brief discussion of the lesions of sarcoid, as they involve the eye, and our experiences with the use of new therapeutic agents.

Three cases of sarcoid uveitis are presented. Two patients had other than ocular involvement, but stress will be placed upon the invasion of the eye and the effects of the drugs on the course of the ocular disease.

Sarcoidosis involves the uveal tract much

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more frequently than it does the sclera, anterior cornea, or conjunctiva. Insofar as the components of the uveal tract are concerned, the iris is affected more often than either the ciliary body or the choroid.

While the posterior surface presents a typical clinical picture of sarcoidosis in cases of the uveal disease, it is not felt that this represents true corneal involvement per se, but, like any other case of a granulomatous uveitis, the primary site is the uveal tract, with exudation plastering itself on the corneal endothelium. The frequency of involvement of the ocular structures by sarcoidosis has been well presented by Woods[17] and Woods and Guyton[18] and need not be dealt with to any extent here.

Case reports

Case 1

L. A., a 15-year-old Negro, was first seen in the eye clinic on August 7, 1950, with the complaint of difficulty in seeing for two weeks. He gave a history of "needle treatments" for a year before the clinic visit; this was found to have been old-tuberculin therapy. He was unable to tell where he had been treated, or the reason for the therapy.

Eye examination. Tension to fingers, lids, and external ocular movements were normal. Vision was counting fingers at 18 inches, O.U.

The corneas were small. Large keratic precipitates were seen, scattered and fatty appearing, throughout the posterior surface of each cornea. An aqueous ray was difficult to demonstrate. There was no circumcorneal injection. Iris markings were difficult to demonstrate, due to the corneal haziness.

The patient was sent to the medical department for a complete work-up, and was hospitalized.

He thought he had been losing weight for several months. There was no history of cough, night sweats, or fever. He had had some exertional dyspnea and unaccountable malaise for a few months. Otherwise, the past history was apparently noncontributory.

Examination revealed a tall, thin Negro, weighing 113 pounds. Temperature, 99.4°F.; pulse, 74; respirations, 20. Chest: pulmonic second sound was accentuated with a soft systolic blow localized in the pulmonic area, associated with a palpable thrill in the second left interspace. Lung sounds were normal to percussion and auscultation. There were several small palpable inguinal nodes, bilaterally.

Chest X-ray studies: heart, normal; moderate lobular enlargement of each hilar region, and increased width of the mediastinum. The enlargement was symmetrical. There was slight stringy infiltration extending from the inferior portion of the right hilus into the right lower chest. Otherwise the lung fields were clear.

Hemoglobin: 101 gm., 14.6 percent; R.B.C., 5.03 million; W.B.C., 6,600 with filaments 38, nonfilaments 2, myelocytes 5, eosinophils 7. Morphology of the cells was within normal limits. Agglutionation tests for typhoid, brucellosis, tularemia, and so forth, were negative; serologic test for syphilis, negative.

A biopsy of an inguinal node was positive for Boeck's sarcoid. Tuberculin tests (1:100,000 and 1:10,000, using P.P.D.), negative. Gastric washings for tuberculosis were negative.

The patient was given one-percent atropine, locally, one drop, O.U., three times a day. A systemic course of ACTH was begun, the first dose was 40 mg., and then the patient received 10 mg. every six hours. A total of 360 mg. was given.

Eosinophil counts and serum electrolyte studies were performed at frequent intervals. The patient's weight and blood pressure were checked daily, and no untoward effects from ACTH were felt.

There was no change in patient's condition, although he felt he "saw a little better." This probably was due to the local pupillary dilatation with the atropine.

The patient was discharged from the hospital, and a check of his vision on December 29, 1950, showed it to be 4/200, O.U. The corneas were still cloudy, there was no change in the keratic precipitates, and the fundi could not be visualized due to the corneal condition.

Case 2

I. M. (No. AC7426), a 21-year-old Negress complained of blurring of vision since August, 1948, and examination in the eye clinic late in 1948 revealed:

Right eye. The pupil was small and bound down with synechias; there was some circumcorneal injection, and many posterior corneal deposits. The fundus could not be visualized. Vision was hand motion at one foot.

Left eye. The pupil dilated except at the 6-o'clock position, where a posterior synechia was present. There were a few fine posterior keratic precipitates, as well as a few deep opacities. Vision was 20/50.

Ophthalmoscopic examination showed a globular, slightly yellowish mass in the lower nasal quadrant, fluffy white nasally, and extending temporally over to the macular area; the whole lesion was deep to the retinal vessels. Some nodular-appearing areas were seen in the inflammatory zone. The impression was that of choroidal sarcoidosis.

A more complete study in the medical dispensary showed:

Chest X-ray studies: Hilar lymphadenopathy, with increased bronchovascular markings extending from the hilar regions bilaterally; this was taken to be compatible with sarcoid. X-ray films of the long bones, hands, and feet were normal.

Hemoglobin, 97 percent, 14 gm.; W.B.C., 3,450, with 44 percent filaments, 50 percent lymphocytes, and six percent eosinophils. There was slight

anisocytosis and poikilocytosis, with target cells. Urinalysis and A/G ratio, normal.

The patient had an enlarged submental node, 4.0 by 2.0 cm., on the right; enlarged cervical nodes, bilaterally; and enlarged nodes in both femoral areas, one on each side measuring 8.0 by 4.0 cm.

After examination, the patient unaccountably absented herself from the clinic, giving no reason for the absence when seen again eight months later. Eye findings were unchanged, except that the corneas seemed a trifle clearer. The patient was hospitalized, a node from the left cervical region was biopsied, and reported as positive for Boeck's sarcoid.

A course of old tuberculin was begun and maintained after the patient's discharge from the hospital. The first dose was one millionth of a milligram. This was increased by one millionth of a milligram at each successive dose. Doses were given twice a week. A final dose of 90 millionths milligram was reached.

The choroidal lesion in the left eye seemed to decrease. Insofar as the right eye was concerned, a wavering clinical course was observed during the tuberculin treatment. At times the patient saw nothing with her right eye; at other times she stated vision was returning. On one occasion, she requested enucleation of the right eye, and on a subsequent visit stated vision in the temporal field was "good," and changed her mind about the enucleation. Vision of the right eye at this time was hand motion at two feet.

This lasted for a few weeks. Shortly after the final dose of tuberculin was given, there was a sudden drastic decrease in vision in both eyes, coming on "very suddenly" one morning, according to the patient. In February, 1950, vision was: O.D., nil; O.S., 20/100.

The patient was then rehospitalized, and a course of urethane was administered (one gm., four times a day) until patient received a total of 100 gm. In June, 1950, vision was: O.D., light perception, no projection; O.S., 14/200. Refraction showed: O.D., unimproved; O.S., with a -1.25D. sph. $\bigcirc$ -0.25D. cyl. ax. $180° = 20/70$.

Follow-up studies showed no further improvement in the eye status, and no appreciable change in the general clinical picture.

CASE 3

R. S. (No. AD466), a 22-year-old Negress, was first seen in the eye clinic, May 29, 1950. At that time she complained of "red eyes and blurred vision." Duration of these symptoms was six weeks. There was no previous history of eye disease.

Eye examination revealed small pupils, with sluggish light reaction. The corneas showed numerous large and small yellowish keratic precipitates; there was marked circumcorneal injection. Vision was: O.D., light perception, no projection; O.S., no light perception.

She was given local one percent atropine, O.U., three times a day, and epinephrine bitartrate ointment three times a day, O.U.

Chest X-ray studies on May 29, 1950, showed probable pulmonary sarcoidosis. The patient was hospitalized July 27, 1950.

Examination revealed a fairly well-developed, moderately nourished Negress. On the arms, trunk, and legs there were reddish, scaly lesions, with raised edges. Some of these lesions appeared nodular. The nature of the lesions was undetermined at the time of admission. There were a few small nodes in the neck and both axillae.

Blood chemistry studies were normal, and there were no signs of either hypercalcemia or hyperglobulinemia.

Chest X-rays showed hilar adenopathy, bilateral; the lower lobes were involved, with evident cystic rarefaction in the fifth, sixth, and seventh ribs posteriorly and bilaterally. Long bones, wrists, and hands, normal. The electrocardiogram was considered abnormal, but nonspecific.

The old-tuberculin test (1:10,000) was negative. Smears and cultures for tuberculosis were negative. Biopsy of a skin nodule on August 8, 1950, was positive for Boeck's sarcoid.

On August 16, 1950, the patient was begun on ACTH (10 mg. were given initially, and 10 mg. given every six hours, until a total of 240 mg. was reached). Clinical response to this drug was evident shortly after the medication was begun. After four days of treatment, the corneas showed some clearing. Vision in the right eye improved to counting fingers at five feet, and in the left eye, it improved to counting fingers at three feet. There was no demonstrable improvement in the skin lesions.

Two weeks later, chest X-ray films showed definite increase in the size of the heart, and increased hilar and pulmonary pathologic processes. No further changes, except a slight increase in the patient's vision, occurred, and the patient was discharged. Vision was: O.D., 20/200; O.S., 3/200.

During the interval between hospitalizations, the patient apparently developed symptoms of systemic sarcoidosis—severe cough, hemoptysis, weight loss, exertional dyspnea, and night sweats. Myocardial sarcoidosis was suspected.

Electrocardiographic studies showed diffuse myocardial damage, nonspecific. X-ray studies of the chest showed cardiac enlargement and pulmonary infiltration, thought to be due to sarcoidosis.

On November 15, 1950, the patient was readmitted to the hospital orthopneic, and in obvious congestive failure. She also had a right facial palsy, peripheral in type, etiology undetermined, which subsided spontaneously over a period of several days. The eye status was the same as at the time of her first discharge from the hopsital.

Since she was in congestive failure, cortisone was contraindicated, and local cortisone was begun (1.4 saline dilution). One drop was used in each eye every two hours, and one percent atropine-sulfate solution was given three times a day. A cardiac regime was begun, and her cardiac status improved. After several days of local cortisone therapy, her vision improved to: O.D., 20/70; O.S., 5/200.

She was discharged from the hospital, and in December refraction showed: O.D., −1.0D. sph. ⊃ −1.0D. cyl. ax. 165° = 20/30; O.S., −0.5D. sph. ⊃ −0.5D. cyl. ax. 90° = 20/70.

Summary

Three cases of Boeck's sarcoid involving the uveal tract are presented.

Case 1 showed precipitates on the corneal endothelium, and vision was reduced to counting fingers at 18 inches, O.U. Enlarged inguinal nodes were present, and biopsy was positive for sarcoid. The patient received a total of 360 mg. of ACTH, systemically administered. No untoward effects were noted from the drug, and there was no improvement in the patient's vision.

Case 2 showed posterior keratic deposits, as well as a choroidal lesion in the left fundus, thought to be sarcoid. Biopsy of an enlarged femoral node was positive for Boeck's sarcoid. This patient received a course of old tuberculin, the final dose reaching 90 millionths of a milligram. After no improvement, urethane was begun, a total of 100 gm. being given. Refraction did not improve the vision in the right eye, which remained light perception, no projection. Vision in the left eye improved from 14/200 to 20/70.

In the third case presented, the patient had myocardial, pulmonary, and skin sarcoidosis in addition to the uveal disease. She received 240 mg. of ACTH systemically and, in addition, she received local cortisone. Improvement was marked. The final refraction gave vision of 20/70 in the left eye which had been virtually blind; in the right eye it improved from light perception to 20/30.

Conclusions

It is felt that ACTH and cortisone may be of some value in the treatment of sarcoidosis involving the ocular structures. Certainly the results in Case 3 warrant further intensive investigation with ACTH and cortisone. Insofar as urethane is concerned, judgment awaits further investigation.

University Hospital (1).

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OCULAR SARCOIDOSIS*

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Mrs. J. F., a white woman, aged 48 years, was seen by me in consultation with Dr. H. M. Katzin on August 17, 1948. The pertinent history was that, in December, 1947, Dr. Katzin did a trephining operation on the left eye for what was ostensibly a chronic simple glaucoma. The tension was controlled temporarily but, two months later, in February, 1948, the tension had risen so high that an iris-inclusion operation was done. Since that time the eye had done poorly and was constantly irritated.

When seen by me in August, 1948, the right eye had a good-sized pupil even though pilocarpine had been instilled that morning. The vision was 20/20 with a −0.5D. sph. and the slitlamp examination was negative. The fundus was normal so far as could be determined without dilating the pupil fully.

The tension of the right eye was 15 mm. Hg (Schiøtz). The left eye had light perception, it was slightly injected, the upper lid was somewhat ptosed, and there was much iris pigment under the conjunctiva beyond the area of the included iris pillar.

With the slitlamp many fine cells were seen in the anterior chamber but there were no deposits on the posterior surface of the cornea. There were many adhesions of the iris to the lens with a good deal of iris-pigment dispersion. The fundus of the left eye could not be seen; only a fundus reflex was obtained. The tension of the left eye was 5.0 mm. Hg (Schiøtz).

Because it was possible that sympathetic ophthalmia might develop and since the vision was reduced to light perception with questionable projection nasally, the left eye was enucleated.

PATHOLOGY

In that portion of the globe (upper half) where the iris inclusion was done, the tip of the cut iris can be seen adherent to the cornea with a small patent canal between the iris and the filtration angle. Schlemm's canal has some round cells in its lumen (fig. 1).

The ciliary body and processes on this side are quite normal. The peripheral choroid and retina here are also normal but, at the region of the equator, a small nodule of epithelioid cells is seen in the nerve-fiber layer of the retina. As the posterior portion is approached another such nodule is seen in the inner layers of the retina.

Near the disc the vessels in the retina and choroid are markedly distended and there are numerous hemorrhages in the outer fiber layer of the retina. The nerve-fiber layer is swollen with fluid.

There is papilledema of the optic nervehead and a fairly large nodule of epithelioid cells and lymphocytes lies in the nervehead adjacent to the beginning of the outer nuclear layer of the retina. A similar nodule is present in the center of the optic-nerve cup. The edema of the nervehead is quite marked in front of the lamina cribrosa (fig. 2).

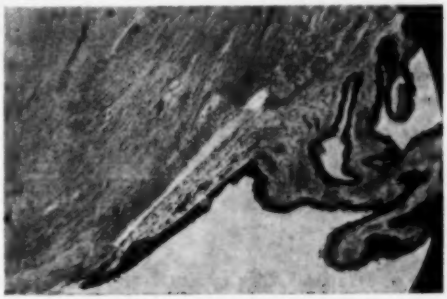

Fig. 1. (Laval). Schlemm's canal showed round cells in its lumen.

* From the Pathology Department of the Manhattan Eye, Ear, and Throat Hospital.

Fig. 2 (Laval). The edema of the nervehead was quite marked in front of the lamina cribrosa.

Going to the other portion of the globe where no operation was performed (lower half) similar nodules of epithelioid cells are seen in the choroid breaking through the lamina vitrea and the pigment epithelium to invade the outer layers of the retina. The involvement of the retina becomes more and more marked as one approaches the equator and the destruction of pigment epithelium is quite pronounced (figs. 3 and 4).

Now vague giant-cell formation is seen but there is no caseation and more and more of the entire thickness of the retina becomes involved. Once the equator is passed, the choroidal involvement becomes quite marked and the normal retinal and choroidal tissues are almost entirely replaced by the inflammatory process.

Here giant cells and lymphocytes are almost as much in evidence as the epithelioid cells and the choroidal vessels are surrounded by lymphocytes (fig. 5).

As the pars plana is approached areas of necrosis are seen with fibrinous exudate extending into the vitreous. The ciliary body on this side contains many giant cells. The root of the iris is involved and the filtration angle and its meshwork are filled with the same cells. Many lymphocytes are in Schlemm's canal (fig. 6).

The remainder of the iris is only slightly involved and there is evidence of moderate adhesions of the iris to the anterior lens

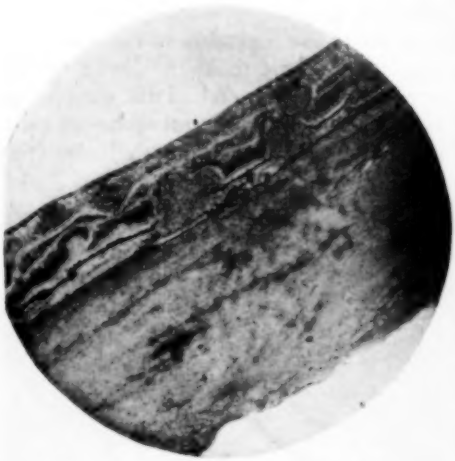

Fig. 3 (Laval). The retinal involvement became more marked at the equator. Destruction of pigment epithelium was quite pronounced.

Fig. 4 (Laval). High-power view of Figure 3.

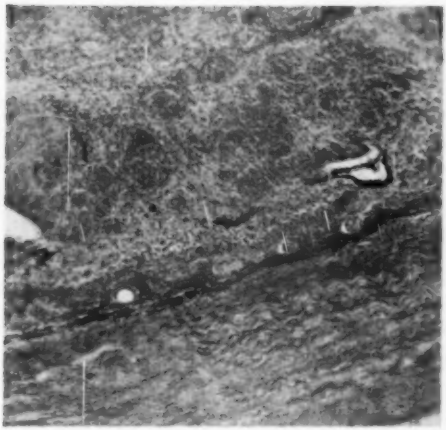

Fig. 5 (Laval). Giant cells and lymphocytes were almost as much in evidence as epithelioid cells. The choroidal vessels were surrounded by lymphocytes.

Fig. 6 (Laval). There were many lymphocytes in Schlemm's canal.

capsule. A small amount of fibrinous exudates is seen in the anterior chamber but no cellular deposits are present on the posterior surface of the cornea (fig. 7).

Further progress

On March 23, 1950, one and a half years after the enucleation of the left eye, Dr. Katzin was kind enough to let me examine the patient's right eye. He had seen in the

Fig. 7 (Laval). Fibrinous exudate was seen in the anterior chamber but no cellular deposits were present on the posterior surface of the cornea.

temporal periphery of the fundus some exudative choroidal lesions.

With the right pupil dilated by paredrine, the vitreous was seen to contain many fine opacities. In the temporal portion of the fundus, near the equator, were numerous small, round, yellowish white choroidal lesions similar to the picture of miliary tuberculosis. There were also some old, healed lesions in the same general area.

The vision of the right eye was now 20/30 minus, using a −1.0D. sph.

Discussion

Inasmuch as the pathologic picture was clearly not one of sympathetic ophthalmia in that (1) the number of giant cells was rather numerous, (2) the tubercle formations had many epithelioid cells and relatively few lymphocytes, (3) the emissaria were not involved, (4) the retina was extensively affected, (5) the iris was only slightly involved, and (6) there was one area of necrosis, I sent the slide to Dr. Verhoeff and to Dr. Reese. Both considered tuberculosis the most likely diagnosis, but could not definitely rule out sarcoidosis.

At the New York Eye and Ear Infirmary the pathology department considered sarcoid the most likely diagnosis. At Mt. Sinai Hospital the general pathology department, headed by Dr. Klemperer, was certain the slide was one of sarcoidosis.

An X-ray study of the chest and of the bones of the hands and feet showed no pathologic process. The tuberculin test (Mantoux) was negative in all dilutions and, when repeated a year later, it was still negative.

Comment

Sympathetic ophthalmia following an iris inclusion operation has been reported but it is extremely rare. I, myself, think that it cannot occur if the prolapsed portion of iris is well covered by a conjunctival flap.

In this case, however, I agreed to an enucleation because the possibility of sympathetic inflammation always has to be considered. We were pleasantly surprised to find we were not dealing with sympathetic disease but were completely taken back at finding evidence of sarcoidosis.

All the confirmatory laboratory work-up was entirely negative but the patient did develop lesions in the right eye. When I saw the patient again in July, 1951, the right eye had 20/20 vision and there were a few pigmentary changes in the periphery of the fundus where the acute small lesions had been present almost a year and a half before.

It is well known that sarcoidosis is a slowly progressing disease which can heal up entirely in one area while beginning to develop in another.

A Mantoux test and X-ray studies of the chest, hands, and feet in July, 1951, were all negative. There were no palpable lymph nodes.

It seems that, so far, the sarcoidosis has been limited to the uvea of both eyes and the operations for the relief of tension were responsible for activation which was so severe that it could not be reversed. If we had had cortisone available at that time it would have been used but with what effect no one can tell.

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OPHTHALMIA NODOSA*

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Ophthalmia nodosa, although a rare disease, is one of exceptional interest because of its remarkable pathogenesis, as well as for the fact that it unites the vegetable and animal kingdoms to ophthalmology. Although it is well known to occur after injury by various insect hairs, especially caterpillar and certain plant hairs, little appears to be known about the specificity of the insects and plants themselves and even less about the toxic material which causes the damage.

The disease has been recognized and well described for at least 60 years. Wagenmann (1895) first named it pseudotuberculosis. Schmidt-Rimpler (1899) called the same disease pseudotrachoma for obvious reasons, and Saemisch (1904) last and most permanently renamed it ophthalmia nodosa. It is not clear which name is more descriptive or accurate.

Duke-Elder gives a brief and accurate summary of the disease in general as follows:

Since caterpillars are the most common cause of the condition, there is of necessity a seasonal incidence from July to October though one case has been recorded in June (Weiss, 1889).

If isolated hairs are blown into the eye and do not penetrate the tissues, an acute catarrhal conjunctivitis frequently associated with a keratitis is excited, which in a short time tends to heal. As a rule this is bilateral. The first case of this nature was reported by Schön (1861) and a considerable number of others are on record (Baas, 1888; Wagenmann, 1890; Laudon, 1891; Knapp, 1897; and others).

If however the caterpillar itself strikes the eye with some force, the tendency is for the sharp hairs to enter the tissues and to migrate inward producing a severe reaction—nodules in the conjunctiva, infiltrates in the cornea, and a severe iridocyclitis with hypopyon and sometimes nodules on the iris.

The first reported case of this type was by Pagenstecher (1883); others followed by Baas (1888), Weiss (1889), Wagenmann (1890), Krüger (1891-1892), Becker (1892); and others. Lawford (1895) collected eight cases; Wagenmann (1921) brought the number up to 40, and Villard and Dejean (1934) added another nine. Since then, one or two further reports have appeared.

For a complete bibliography of the older literature on ophthalmia nodosa, reference is made to the excellent articles by Stargardt (1903) and Teutschlaender (1908). Kinukawa and Matsuda (1939) have reviewed the more recent literature and contributed additional experimental work.

Our interest in the problem was aroused when one of us, on a visit to the Gundersen Clinic of La Crosse, Wisconsin, in October, 1947, was asked to see a patient in consultation with Dr. George Ridout to whom we are indebted for the opportunity of studying this case.

CASE REPORT

Mr. A. S., a 65-year-old farmer from Spring Grove, Minnesota, came to the clinic on October 17, 1947, relating that 10 days before, while working in his garage, he picked up a towel from his work bench to wipe his face. He apparently did this thoroughly and with some vigor. He immediately felt considerable smarting in and around his right eye.

On examining the towel, he found that he had crushed a "caterpillar cocoon"‡ and rubbed some of the material into his lower conjunctiva. The

* Presented at the 86th annual meeting of the American Ophthalmological Society, Hot Springs, Virginia, June, 1950.

† By invitation.

‡ It is not perfectly clear whether this was an adult caterpillar or a chrysalis. The material recovered from the towel consisted almost exclusively of caterpillar hairs, but some caterpillars utilize many of their own hairs in making their cocoon.

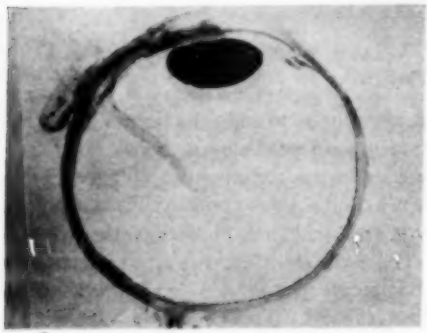

Fig. 1 (Gundersen, Heath, and Garron). Showing principal areas of inflammation at limbus and in anterior chamber, iris, and ciliary body.

area around the eye was wiped off with 70-percent alcohol but the smarting and burning continued and the eye became inflamed. He was seen by his local physician for two days thereafter, but local irrigations and applications did not help and, when his eye became intolerable, he was driven 40 miles to La Crosse for specialized medical help.

He was first seen by Dr. Ridout on October 10th, three days after the injury. The patient was a healthy, vigorous farmer with no obvious ailments except for his eye disease. The right eye appeared tremendously inflamed and moderately irritated. It could barely be opened voluntarily. There was great chemosis of the lower bulbar conjunctiva. The conjunctiva was elevated several millimeters over the scleral surface and there were focal hemorrhages in it.

The cornea was lusterless especially in its lower one third due to edema which increased in intensity toward the lower limbus. Slitlamp examination revealed 12 to 15 fine, brown hairs in the superficial layers of the lower cornea. They were at different levels in the stroma and pointed in various directions.

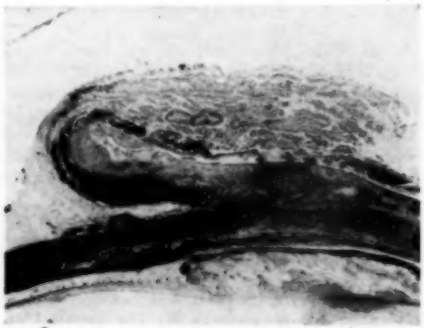

Fig. 2 (Gundersen, Heath, and Garron). Granulomas in sclera and conjunctiva.

The aqueous was slightly turbid, showed a positive Tyndall beam, and contained many cellular elements and some fibrin.

The left eye was completely normal.

Under topical cocaine anesthesia several hairs were removed from the corneal epithelium with a curette and others were removed with a fine spud. An attempt was made to remove some of the hairs from the lower bulbar conjunctiva with less success. It was obvious that, due to the deep location of many hairs in the cornea, all could not be removed by this procedure. The patient was then admitted to the hospital where the eye was thoroughly atropinized and continuous cold compresses applied.

The eye did not improve in the hospital. On the eighth day after injury it was noted that there was tremendous redness, induration, and tenderness of the lower globe. A violent acute iritis was obvious and slitlamp microscopy revealed that several caterpillar hairs were in the anterior chamber. The intraocular pressure measured 18 mm. Hg (Schiøtz).

In the hope that some of the hairs in the anterior chamber might come out with the rush of aqueous following paracentesis, three such operations were performed—on October 20th, 21st, and 23rd. Each one was done with a keratome in the upper limbus. Whether or not any hairs came out is questionable, but there was temporary relief from pain following each paracentesis, especially the last.

The pain returned and became more intense than ever. The inflammatory reaction increased. On October 29th, 22 days after the injury, it was noted that the chemosis was estimated to be five mm. in elevation. The corneal edema had increased, and a 1.0 by 2.0-mm. bulla could be seen in the corneal epithelium near the lower limbus.

Slitlamp microscopy at this time revealed several hairs still in the deep corneal stroma. On the surface of the iris at the 7:30-o'clock position, there were three separate fine hairs. Several posterior synechias had already formed. The ocular tension

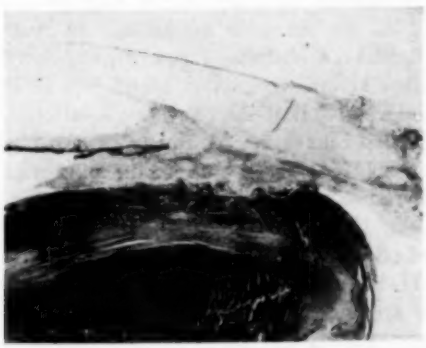

Fig. 3 (Gundersen, Heath, and Garron). Liquefaction necrosis in iris, hypopyon, wrinkled lens capsule.

was normal by digital palpation. The visual acuity was reduced to 6/60.

In the hope that the inward migration of more hairs might cease and that removal of those already in the iris might ameliorate or cure the condition, an iridectomy was contemplated. It was thought that this operation might at the same time prevent occlusion of the pupil.

Therefore, on October 29th, an iridectomy was performed, excising the lower outer quadrant of the iris. The specimen was fixed in formalin. An uneventful convalescence followed although the inflammation never subsided completely. The patient was discharged from the hospital on November 4th.

On November 11th, the patient returned to the clinic. The eye had healed reasonably well. There was little ciliary congestion except in the lower one half of the globe. The chemosis had subsided, though the bulbar conjunctiva below was somewhat thickened and red. Subcapsular lens opacities were noticed for the first time. The vision had fallen to 6/90. Enucleation was suggested.

The patient returned on April 7th, complaining that he had had continuous pain for the past month. The cornea had become more opaque. The lens could not be readily examined and there was marked iridocyclitis. Enucleation was then accepted and done on April 7th, five months after the injury. This specimen and the iris biopsy specimen were sent to Dr. Parker Heath of the Massachusetts Eye and Ear Infirmary for study.

Pathology report

The stained and mounted specimen of iris measured 4.5 by 2.0 mm. It was somewhat folded and showed an acute inflammation characterized by pus cells, hemorrhage, and necrosis. A caterpillar hair was found on its surface.

The fixed, intact right globe measured 22 mm. horizontally and 23 mm. vertically.

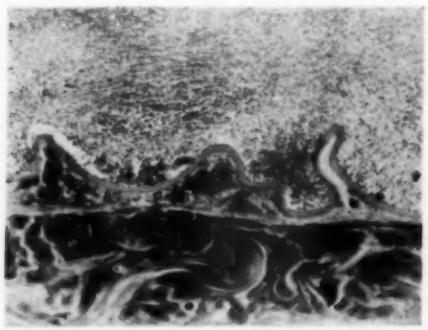

Fig. 4 (Gundersen, Heath, and Garron). Detail of hypopyon and lens.

Fig. 5 (Gundersen, Heath, and Garron). Interstitial keratitis and dilated corneal vessels.

There was absence of iris from the 6:30 to 9-o'clock positions, indicated by transillumination. A corneal opacity partially obscured the region of the coloboma. About one fifth of the cornea showed a loss of transparency. The vitreous, especially the posterior portion, was fluid. The lens and retina were in position. The eye was opened horizontally.

Microscopic findings. The cornea showed edema of the epithelium and a deep stromal vascular ingrowth consisting of rather large

Fig. 6 (Gundersen, Heath, and Garron). Cornea in region of surgical perforation, showing granuloma with hair shaft in the center.

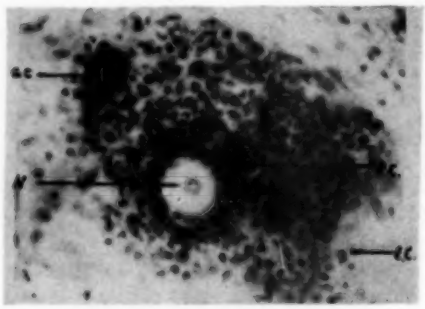

Fig. 7 (Gundersen, Heath, and Garron). Spine of caterpillar hair within a lesion and giant cell. (GC) Giant cell. (PC) Polymorphonuclear cells. (EC) Epithelioid cells. (H) Hair.

dilated vessels. A healed, perforating, limbal wound was noted on the temporal side. Descemet's and Bowman's membranes were interrupted and deflected into the stroma. A few polymorphonuclear cells were seen in the cornea, especially about the vessels.

Episcleral vessels showed considerable engorgement. Edema was noted in the remaining tags of conjunctiva. The anterior chamber showed a marked hypopyon applied to the inner surface of the swollen and edematous cornea. Considerable debris from liquefaction necrosis was present.

The iris showed liquefactive necrosis and some focal accumulations of cells, mostly lymphocytes.

The limbus, sclera, rectus muscles, and ciliary body showed similar lesions. These were granulomas, containing in their centers a section of a hair or spur surrounded by a few polymorphonuclears and leukocytes. Outside of this was a wider zone of epithelioid cells and, encircling this a zone of mixed cells, mostly lymphocytes. There were a few giant cells of the foreign-body type. Each granuloma invariably showed this arrangement. As many as 20 tubercles could be seen in a single low-powered field. The lens showed a wrinkled capsule and some cortical opacification, a few fluid clefts, and some epithelial proliferation.

Behind the lens in the anterior vitreous there was a necrotic abscess containing a caterpillar hair. There was some extension of the inflammatory reaction backward into the vitreous. A few eosinophils were present.

The ciliary body, like the iris, showed a severe necrotizing inflammation; its pigment epithelium was disorganized.

The choroid showed lymphocytes about the vessels, and other focal accumulations of these cells with a few macrophages and plasma cells. There were a number of zones of chorioretinitis. The glass membrane was wrinkled and took a basophilic stain.

The retina showed perivascular infiltration of polymorphonuclears and some nodules on its inner surface composed of macrophages, lymphocytes and plasma cells. There was a partial necrosis of the ganglion cells. The

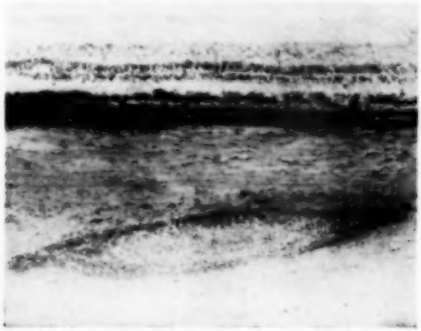

Fig. 8 (Gundersen, Heath, and Garron). Oval granulomatous lesion in sclera.

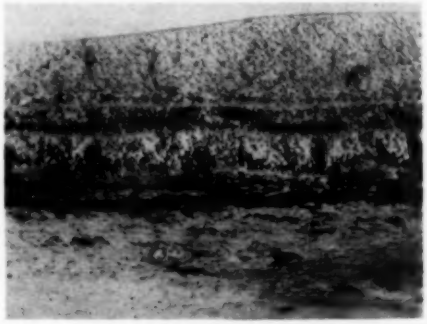

Fig. 9 (Gundersen, Heath, and Garron). Albuminoid exudates in retina.

retinal pigment layer showed areas of proliferation and some phagocytosis by macrophages. The nerve-fiber layer was edematous. There were marked destruction of the rods and cones and some loss of both inner and outer nuclear layers.

Near the nervehead on the temporal side there appeared an area of old hemorrhage and laked blood containing a few red cells, polymorphonuclear cells, and remnants of a disorganized external granular layer. A well-marked polychromic staining of the two nuclear layers was present—the outer stained pink, the inner blue. The retinal vessels in general were cuffed with polymorphonuclear leukocytes, and other inflammatory cells.

The nervehead was elevated by edema and showed focal inflammatory cells about the central vessels. The meningeal spaces were wide and contained a few cells, probably glial in origin.

Comment. The reactions from the hairs and spurs were severe. The inflammation has elements of a direct necrosis from venom and shows some of the phenomena of sensitivity. There was a moderate amount of eosinophilic cells. The attempt by rabbit inoculations to test out the direct toxicity proved negative. This suggests that sensitization may be an essential part of the reaction. It seems likely that, as a result of multiple exposure, a sensitive state could develop.

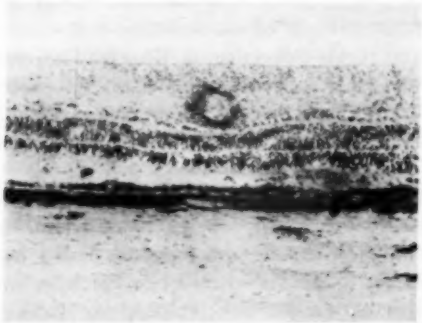

Fig. 10 (Gundersen, Heath, and Garron). Perivascular infiltration in the retina and polychromic staining of outer and inner nuclear layers. (Inner nuclear layer stains pink; outer nuclear layer stains bluish.)

Fig. 11 (Gundersen, Heath, and Garron). Nervehead, showing edema and optic neuritis.

Because of its design with the spurs inclined toward the sharp distal end, penetration of the hair must be by way of the base. The brittleness of the shaft and its method of breaking off into bits, thereby sharpening the larger proximal diameter probably facilitates its penetration. The usual presence of a shaft of hair or of a barb in each granuloma suggests that the reaction to the toxic substance within the shaft may be achieved after the hair becomes relatively fixed.

From the design of the hair, the venom seemingly could leak out of the lumen at any time. However, it is probable that when the toxic substance escapes, enough cellular response develops to immobilize the shaft. This would not be true if the hairs were in the

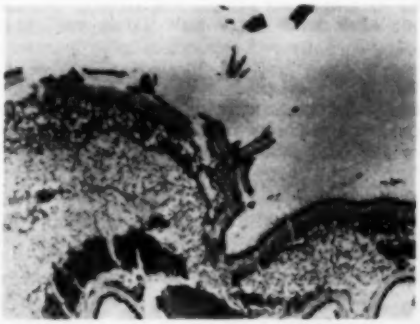

Fig. 12 (Gundersen, Heath, and Garron). Section of caterpillar hair, showing origin of hair.

Fig. 13 (Gundersen, Heath, and Garron). Caterpillar hair.

fluid of the anterior and vitreous chambers. Then there would be a diffuse reaction of necrosis and abcess.

The size of the poisonous hairs varies. A long specimen measures six mm.; its diameter approximates one tenth of one mm. The spines which are arranged about the shaft of the hair decrease in number and size toward the distal end. It would seem from the lesions that the secondary barbs can cause minor granulomatous responses.

The toxin probably originates, as described by Gilmer, from the unicellular venom gland connected to the hair cavity. The difference in staining of the retina, the acidophilic outer layer compared with the basophilic inner layer, requires considerable latitude of interpretation. It may suggest that more toxic material reaches the inner layers of the retina by way of the vitreous.

As pointed out by Verhoeff, the fixation is always an important element in causing differences in staining various layers of the retina. There were noted some changes in the retinal pigment layer which probably antedated the acute necrotizing process. These consisted of old pigment migrations, proliferations and some mineralization. The rods and cones were only fairly well preserved.

Summary of diagnosis. Endophthalmitis from intraocular caterpillar hairs—ophthalmia nodosa.

The disease in general

Unless ophthalmia nodosa is often unrecognized, it must be considered a rare disease. We have observed only two cases. In the Pathology Laboratory of the Massachusetts Eye and Ear Infirmary only three specimens have been examined. Inquiries sent to both the University of Minnesota and the University of Iowa indicate that the disease is equally rare there. These are the two university clinics nearest to the site of origin of the reported case.

The seriousness of the disease in this case and its unfortunate outcome must also be considered as unusual. Most eyes injured by caterpillar hairs, either blown in (when the disease is apt to be bilateral), or injured directly by the larva thrown against the eyeball, do recover after a varying period of ocular inflammation.

The migration of caterpillar hairs into the ocular tissues has been observed. Igersheimer (1927) removed such a hair from the anterior chamber. Nodules in the iris have been recorded; Becker (1892) and Reis (1903) saw a hair in the choroid. Ogiu (1907) experimentally found that hairs had reached the optic disc. Perhaps not more than 10 or 20 percent of the 50 cases reported have shown hairs on the iris, choroid, or retina.

The disease usually runs a milder course. After the initial period of inflammation the eye usually whitens, to be followed by repeated periods of exacerbation and remissions of the inflammation. This may last for years: up to two and one-half (Krüger, 1892); four years (Wagenmann, 1921); seven years (Krausse, 1925); and 10 years (Reis, 1900, 1903).

In all probability exacerbations are often due to movements of the hairs from one location where a granulomatous lesion has formed to another where a new lesion begins. Such movements are probably not sudden, but do vary in speed depending on several factors: the type and condition of the hair, its barbs, and particularly the part of the globe in which they happen to be.

The movement of the surrounding tissue is doubtless of great importance, since the hairs themselves have no propulsive power and therefore any movement must be passive. The constant though microscopic friction between corneal lamellae or scleral lamellae with each pulse beat and respiration could explain this passive movement.

Similarly, since the uveal tract is never at complete rest, hairs, especially those with barbs, can easily be pushed along in one direction. This raises the question as to whether one hair can produce several discrete spherical tubercles as it travels along or produces one that is cylindrically shaped.

The tubercles seen in this case were not uniformly of the same age as judged by their histology. Hairs were not always found in the center of each granuloma. It is therefore thought that a single seta does produce several lesions or probably a cylindrical lesion and that this movement explains the chronic nature of the disease, as well as its remissions and exacerbations.

Nature of caterpillar hairs and their toxins

Mr. A. S. brought with him the towel with which he had wiped his face, and it still contained much of the crushed caterpillar. The hairs or setae were approximately six-mm. long and 0.1 mm. in diameter. They were gently curved, contained a medullary canal partly filled with a dark brown, fine granular material, and seemed to be brittle since so many setae were broken by even gentle handling.

The setae uniformly ended in an exceedingly sharp point, but in no hair could an opening be found. This agrees with the observation of Stargardt and others. Along each seta were short barbs pointing distally and away from its base. These were regularly spaced on alternate sides of the shaft. In order for such hairs to migrate through tissue it is obvious that they must first be broken from the animal's body and travel base first.

Three weeks after the injury, the members of the family brought in several pupae gathered from the farm. It was at first thought that these might aid in the identification of this particular caterpillar; so two of the pupae, with the macerated animal, were sent to Charles L. Remington of the Osborn Zoological Laboratory of Yale University. His opinion was:

> The two pupae appear to be of the same species, but I have not gone into the rather elaborate steps necessary to identify pupae, since these particular ones are not necessarily critical to your case. The reasons I believe it is unsafe to assume this caterpillar and these pupae are of the same species as the cocoon on the towel are: (1) *Isia isabella* has never been incriminated as an urticator, although one other species of the family Arctiidae, *Euchaetias egle*, is a known urticator; (2) *I. isabella* is extremely abundant everywhere, so finding several near the offending towel lends little support to conspecificity; (3) setae of caterpillars are of little, if any, value in establishing identity, and members of any one family would probably have almost identical setae.

Additional setae were likewise sent for identification to Paul M. Gilmer, entomologist of the Georgia Coastal Plain Experiment Station. The following comments are quoted from his personal communication:

> I was unable to identify the setae which you sent and you are correct in your assumption that in general these setae are very similar in a large number of genera of caterpillar. The species involved might be any one of a large number. Most of the Arctiids have setae similar to those included and it is quite possible that the insect involved was, as you suggest, *Isia isabella*. However, there are a number of other species equally common and about as likely to cocoon in things like towels or other clothes left folded where the larvae might reach them.
>
> It is a little difficult to know just what may have happened in this case. I would imagine the mechanical irritation from embedded setae in the cornea and sclera alone might cause a pretty serious inflammation of the eye. There is also the possibility of infection from the organisms introduced with the setae and, of course, the possibility of actual poisoning from secretion contained in the caterpillar hairs.
>
> Individuals appear markedly different in their sensitivity to the toxic principle contained in these caterpillar hairs. In some people even with hairs

from the same individual caterpillar we have had reactions varying between almost none whatever to the production of large wheals, violent and intolerable itching and burning lasting from seven to 10 days.

Because of this unexplained variation it is a little difficult to predict what might happen when we attempt with laboratory animals to duplicate conditions found in clinical cases. The fact that you got negative results from Isabella caterpillar hairs with the rabbits would by no means exclude the possibility that this was the species involved in the case you had.

In regard to the nature of the toxic substances, they are very definitely neither formic acid nor cantharidin. I did quite a little work with the assistance of Dr. Hirschberger, toxicologist of Minnesota Medical School, but we were unable to get very far with the problem.

In only one species do we have a solubility for the toxin. In this species, the brown tail moth, Dr. Tyzzer was able to get solution with hot water which when filtered still gave typical toxic reaction. In all of the species we attempted to work with, it appeared quite definitely that the protoplasm of the toxic cell was in itself the carrier.

All the toxic cells showed granules in the protoplasm or a diffusion of what probably was submicroscopic particles which stained very heavily with the hematoxylin stains. It was our opinion that the toxic material was probably identified with these staining bodies. It seemed to be of a protein nature and more nearly related to the venoms of spiders or snakes than any other type of toxic material.

It must be exceedingly toxic because I, myself, have experienced from a few hairs of some of the Megalopygids, almost temporary paralysis of the muscles of the hand and, since coming to Georgia, have contacted a number of physicians who reported cases where the sting of a single caterpillar of *Largoa crispata* has produced very serious general systemic reactions such as high temperatures (103°-104° F.), partial collapse, tremors, and disturbances of vision. The quantity of venom introduced could certainly have been only a few milligrams.

The anatomic characteristics of various types of caterpillar hairs have been carefully described by Stargardt (1903) and by Teutschlaender (1908). They thought that the pathologic changes were due in part to the mechanical irritation of the hairs themselves but chiefly to a toxic substance secreted by a gland situated at the base of the hair under the dermis of the larva (Teutschlaender, 1908; Weill, 1926; Villard and Dejean, 1934).

Gilmer (1925) finds urticating spines to be of three morphologic types: (1) The primitive hair, (2) the modified single hair which belongs to *Isia isabella*, and (3) the spine variety, a shorter, very sharp, pointed hair. He states that eight distinct families have been found to contain poisonous species.

Although considerable was learned about the general properties of the toxic material, as was noted in his communication, nothing concerning its chemical nature could be found out. It was evident, however, that it is not formic acid or catharidin as had been suspected, but some highly toxic substance, very closely associated with the protein molecule of the trichogen cell itself, rather than a venom secreted by the cell.

Gilmer further states that the exceedingly minute quantities of material obtainable, the great difficulty in separating it from other cell contents, and finally its refracting nature makes the probability of solving the problem of the chemical nature of the venom exceedingly remote.

It therefore follows that the exact identity of the "caterpillar cocoon" causing ophthalmia nodosa in this case has not been established. It probably belongs to the family Arctiidae and may be *Isia isabella*, though the latter has rarely been considered a dangerous larva. Nevertheless, Moore has described a severe endophthalmitis in a patient struck by a "woolly bear" caterpillar (*I. isabella.*)

Animal experiments

Since the early work of Krüger (1892), Becker (1892), Strömann (1894), a great deal of experimental work has been done on the action of caterpillar hairs in animal eyes, chiefly on rabbits. More elaborate animal experiments were performed by Stargardt (1903) and Teutschlaender (1908). Dejean and Harant (1934) and Villard and Dejean (1934) demonstrated various phases of the disease by biopsies taken at intervals.

The inward migration of caterpillar hairs into the eye has been clearly demonstrated. Nevertheless much confusion exists regarding the constancy with which hairs from

caterpillars thrown or pressed against the living animal eye reproduce the disease as seen in humans.

Strömann (quoted from Stargardt) noted that the experimental and clinical findings fail to coincide. He was unable to get hairs from different species to penetrate further into the eye than Descemet's membrane. Stargardt tried several species of caterpillars 12 times on suckling pigs and four times on rabbits and failed to produce endophthalmitis.

Dejean and Harant concluded that rabbits have a milder reaction to the disease than man. In no case did the reaction in rabbits last longer than 25 days and, in no case, was it possible to perforate the cornea completely with the hairs.

An attempt was made in connection with the case reported to produce ophthalmia nodosa in the eyes of rabbits. Healthy adults were utilized in two sets of studies. In the first group, the eight months' old setae recovered from the caterpillar within the towel were used for implantation into the eyes; whereas, in the second, the freshly plucked setae from a live caterpillar (*I. isabellæ*) were used in like manner. Operative procedures were performed under general anesthesia.

Four rabbits were used in the first series of experiments. The hairs used were dry and brittle; perhaps due in part to their age. Several operations were performed as outlined in Table 1 and setae were implanted. Being brittle and sharp pointed, they were maneuvered into position with difficulty. Those placed on the iris and in the anterior chamber could be readily observed during the postoperative period. Fragmented hairs were also noted under the conjunctival flaps in these eyes, inadvertently left there during the operations.

In the second series of experiments, setae from a live caterpillar (*I. isabella*) were implanted into the eyes of four additional rabbits. The hairs from this caterpillar were indistinguishable microscopically from those in the first series.

Results

Postoperatively, the eyes of all rabbits

TABLE 1

Animal experiments in ophthalmia nodosa

	Eye	Operative Procedure	Observations
First series: 7-2-48; Hairs from caterpillar in case reported. Eight eyes of four rabbits.	1	Hairs placed freely in lower cul-de-sac.	No reaction at any time. Hairs not observed after two days.
	2	Hairs placed under conjunctival flap, 3 mm. from limbus at 6-o'clock.	Operative reaction for few days Hairs noted subconjunctivally with no reaction.
	3	Hairs placed intracorneally under lamellar flap.	Hairs noted intracorneally. No reaction.
	4	Conjunctival flap. Keratome incision limbus at 12-o'clock. Iris withdrawn, hairs placed on iris stroma; iris replaced.	Hairs noted on iris. No reaction. Fragmented hairs under conjunctiva.
Second series: 11-2-48; Hairs from live caterpillar (*Isia isabella*). Eight eyes of four rabbits.	5	Keratome incision limbus at 12-o'clock. Hairs placed freely in anterior chamber.	Hairs noted on iris surface. No reaction. Fragmented hairs under conjunctiva.
	6	Conjunctival flap, sclerotomy 6 mm. from limbus. Hairs inserted deeply into vitreous chamber.	Blood streaks with? hairs observed for four weeks after which vitreous cleared. No further reaction.
	7	Conjunctival flap, sclera incised. Hairs placed in scleral wound.	Hairs noted under conjunctiva No reaction.
	8	Conjunctival flap, scleral incision and attempted implantation hairs in ciliary body.	Hairs noted under conjunctiva No reaction.

used in these studies were observed daily for the first two weeks and thereafter less frequently for a period of six months.

Those eyes in which setae had been placed in the lower cul-de-sac showed no reaction at any time. In fact, the hairs could not be found in the cul-de-sac after the second day. The remaining eyes showed the usual postoperative reactions incident to the procedure, after which they rapidly healed and thereafter showed no reaction.

Those placed in the vitreous were not definitely observed after the operation, though a few blood streaks were seen with the ophthalmoscope. These disappeared in three to four weeks, the vitreous remained clear thereafter.

Those placed under the conjunctiva, in the iris, and in the anterior chamber remained clearly in view during the entire period of observation with no visible reaction in the tissues.

Since the clinical picture of ophthalmia nodosa could not be produced by these experiments, the eyes were not studied histologically.

Conclusions

1. A case of ophthalmia nodosa caused by caterpillar hairs is reported in which the intraocular migration of the setae caused an intractable endophthalmitis resulting in enucleation.

2. The exact identity of the larva causing the disease is unknown but due to the exact similarity of its setae with *Isia isabella* it is strongly suspected that it belongs to the same family, Arctiidae.

3. A complete histologic description is given of the globe enucleated five months after the injury. The histology of the affected iris, procured by iridectomy 22 days after injury is also included.

4. Experimental attempts failed to produce ophthalmia nodosa in the eyes of rabbits employing the same setae which caused the disease in the case reported, as well as fresh setae from *Isia isabella*. These setae were placed in the lower conjunctival sac, under the bulbar conjunctiva, between the corneal lamellae, on the iris, in the ciliary body, and in the vitreous.

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EXPERIMENTAL RETINAL DETACHMENTS AND THE USE OF PHYSIOLOGIC GLUE IN RABBITS' EYES*

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During 1949, three articles[1, 2, 3] discussed the use of physiologic glue in ocular surgery. Tassman[1] mentions its use in human retinal detachments as a method to obtain adherence between the retina and the choroid. This possibility interested us. We, therefore, produced retinal detachments in 25 rabbits' eyes and attempted reattachment using a physiologic glue.†

Experimental retinal detachments have been tried since the time of Chodin, in 1875. Duke-Elder[4] points out that they do not exactly resemble detachments in humans, which occur in diseased eyes. They tend to fall into four groups:

1. An "exudative detachment" is produced by substances which induce an exudative chorioditis.
2. "Injection of chemical substances" into the globe, or of a foreign protein, produces retinal detachments.
3. "Withdrawal of vitreous" has been done to produce retinal detachments.
4. "Mechanical detachments" are produced by a spatula inserted under the retina.

Up to 1934, when Castroviejo[5] reinjected vitreous under the mechanically produced detachment, all methods had a high incidence of reattachment. When done by his method

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†Lyophylized plasma supplied by Sharpe & Dohme Chemical Company, and bovine thrombin by Parke-Davis Company.

Fig. 1 (Robertson and Shirley). Retina detached. No glue used.

the detachments remained for several months. Castroviejo had no explanation of why his method worked and the others did not. It has been suggested[6] that the hyaluronic acid in the vitreous undergoes partial depolymerization by the action of the enzyme hyaluronidase, the resulting fluid aiding in the persistence of the retinal detachment.

Technique of detachment

The method of Castroviejo was used, general anesthesia being obtained by the injection of 40 mg. of pentobarbital per Kg., intraperitoneally. The pupil was widely dilated with atropine. All detachments were made superiorly.

The conjunctiva was incised, the superior rectus muscle detached, and a figure-of-eight catgut suture inserted at the equator of the globe. Between the arms of this suture a cataract knife was plunged into the vitreous, producing a retinal tear. A 0.5 cc. of vitreous was withdrawn through a blunt No.-19 needle.

With an iris repositor, the retina was detached from the choroid; this can be watched by an assistant with the ophthalmoscope. The vitreous was then reinjected between the retina and choroid. While this was being done, the scleral suture was held taut to keep the reinjected vitreous within the eye, after which the suture was securely tied. The superior rectus was reattached and the conjunctiva closed.

The operated eyes were examined twice a week. Fourteen eyes were lost, following the detaching operation, from the following causes—traumatic (operative) cataract, two; retinitis proliferans, three; massive detachment, one; corneal ulcer, two; glaucoma, one; and five rabbits died of pneumonia.

Thus, out of 25 eyes there were 11 which we considered satisfactory for observing the efficiency of physiologic glue in the reattachment of the retina. Of these 11, three were kept as controls. Therefore, there were eight eyes on which physiologic glue was used to produce reattachment of the retina.

Technique of reattachment

Brown and Natz[2] found that high concentrations of physiologic glue injected into the vitreous produced a violent iridocyclitis. These workers and Tassman have found that the best concentration of plasma to thrombin is 1:3, which we therefore used.

To remove the subretinal fluid a superior approach over the detachment was made. The conjunctiva was incised and a No.-19 needle was inserted into the subretinal fluid. Fluid vitreous was withdrawn and one drop of plasma and three drops of thrombin were injected, using the needle already in place for one substance, and a second adjacent needle for the other substance.

Results

At the end of the operation, the retinal detachments appeared smaller than previously.

Following this the vitreous became hazy and the fundi, in some cases, were not seen clearly for several weeks. A severe chorioretinitis ensued. In four cases, the eyes became phthisical.

Seven to 12 weeks after the reattachment operation, eight eyes were obtained for sectioning, along with three controls. The sections showed that the retinas of the three control eyes were not reattached, but that the retinas and choroid were healthy (fig. 1). All eyes in which the glue was used showed evidence of severe chorioretinitis with almost complete destruction of the retina (fig. 2); four eyes were phthisical.

Conclusions

Physiologic glue, when used to reattach retinas in eight rabbits' eyes, caused a severe chorioretinitis and destruction of the retina. Until further experimental work is done, such a procedure should not be used on humans.

Banting Institute, 100 College Street.

We are indebted to Dr. Clement McCulloch for his assistance.

Fig. 2 (Robertson and Shirley). Retina detached; glue used to reattach. Note the destruction of the retina and choroid.

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Ophthalmic Miniature

In the same manner they (the German ophthalmologists) supposed a drawing of the pupils upwards and inwards towards the nose to be a diagnostic symptom of syphilitic iritis, which is not the case in England. The eyes of the good people of Great Britain and Ireland seem rather repugnant to such minute arrangement.

Guthrie, *Lecture on the Operative Surgery of the Eye*, 1830.

BILATERAL UVEITIS, POLIOSIS, AND VITILIGO*

WITH AN HEREDITARY FACTOR

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The Vogt-Koyanagi syndrome is one of the most striking syndromes in ophthalmology. The complete syndrome is comprised of bilateral uveitis, poliosis, alopecia areata, vitiligo, and dysacousia.

REPORT OF A CASE

A 34-year-old Negress gave the following history:

In 1944, she noted the onset of slight pain and redness in her right eye with diminution of visual acuity. Her symptoms persisted, and she consulted an ophthalmologist five times from October, 1944, to December, 1945.

The clinical impression was uveitis, O.D.; and in December, 1945, a complicated cataract was first observed. The treatment consisted of atropine only. The left eye was asymptomatic during this time.

In 1947, she observed a white cilium on her left lower lid. After plucking, it grew back pigmented. About this same time, she observed white spots appearing first on her forearms, and subsequently on her face, trunk, and legs. The vitiligo has been progressive.

A physical examination and blood tests performed after the onset of her vitiligo were reported negative to the patient by her family physician.

In 1949, she consulted an optometrist because of diminished visual acuity in her left eye. Glasses were prescribed without subjective improvement. She consulted her optometrist three times subsequently because of progressive visual loss. On her last visit in October, 1950, she was advised to seek medical attention.

On January 10, 1951, I first saw her as an emergency case at the Grace-New Haven Community Hospital with a complaint of marked reduction in visual acuity in the past 24 hours.

Her past history revealed nothing which seemed of significance. She had had measles, mumps, pertussis, and varicella in childhood. There were no operations or serious illnesses.

Her review of systems was negative except for a chronic dry cough of two years' duration attributed to excessive smoking by the patient. There were no symptoms referable to hypothalamic or to endocrine involvement.

The patient had resided in New Haven and New York City exclusively. She was married in 1935 and divorced in 1937. There were no pregnancies.

For the past two years she drank excessively on week-ends. She smoked one and one-half packs of cigarettes a day. Her weight had averaged 130 pounds for more than 10 years. She was employed as a domestic until six months prior to admission.

Her father died at the age of 56 years. The cause of death was said to be "diabetes and cirrhosis of the liver." Her mother was aged 50 years and in good health. Her brothers, aged 21 and 31 years were living and well.

Her paternal aunt died at the age of 34 years from injuries sustained in an automobile accident. Information from members of the family revealed she had developed "white spots" on her hands, arms, and face several years before her death. Her paternal grandfather died at 60 (plus) years,

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cause undetermined. He similarly had "white spots" on his legs, arms, and face, but involvement was less severe than in his daughter.

Although there was a common factor of vitiligo, an infectious element could be ruled out because there was no contact between the patient and these relatives. There was no family history of ocular disease.

Pertinent physical findings on admission: Her temperature was 99°F. Her blood pressure was 180/100 mm. Hg and was never over 140/90 mm. Hg subsequently. The

Fig. 1 (Flynn). Note vitiligo around both eyes and the complicated cataract, O.D.

conjunctiva was slightly injected, O.S. Her tension (Schiøtz) was: O.D., 10 mm. Hg; O.S., 76 mm. Hg. Her cornea was hazy, O.S.

The right eye showed seclusion of the pupil with iris atrophy and a complicated cataract (fig. 1). The left eye had a dilated fixed pupil with irregularity due to posterior synechias. Light projection was poor in the temporal area. The funduscopic examination was unsatisfactory due to corneal edema.

Her skin showed vitiligo involving over two thirds of the body surface with striking symmetry and following the anatomic distribution of the peripheral nerves and/or vessels (figs. 2 and 3).

Areas of thick hair-growth were free of vitiligo except on the nape of her neck where there was an associated area of poliosis.[1] The remainder of the physical examination was negative.

The tension in the left eye responded dramatically to retrobulbar procaine plus topical pilocarpine (two percent) and neosynephrine (five percent). It dropped to 19 mm. Hg in 12 hours, and subsequently dropped to 4.00 mm. Hg nine days later.

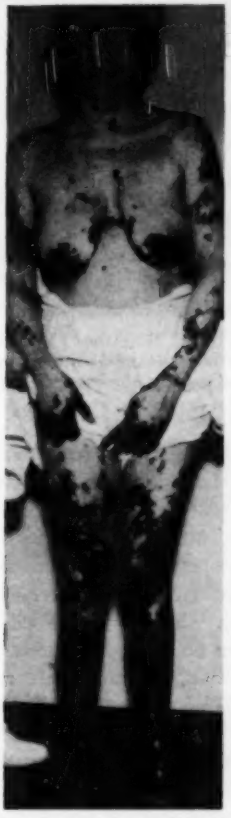

Fig. 2 (Flynn). Photograph showing extent and symmetry of the vitiligo.

When the corneal clearing permitted slit-lamp examination, there was a two-plus flare and old pigmented keratic precipitates. The fundus details were blurred by the cloudy media, but the disc appeared depressed temporally. The visual acuity was 5/200.

Medical control of the secondary glaucoma was unsatisfactory and, in an interval

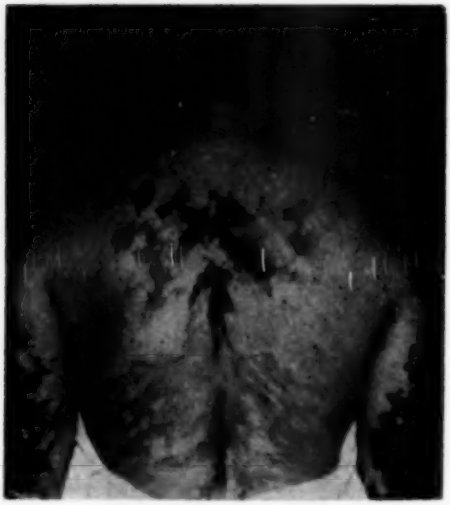

Fig. 3 (Flynn). Note the "Christmas tree" pattern of the relative and absolute areas of vitiligo which correspond to the anatomic distribution of the peripheral nerves and vessels.

between elevations, an iridectomy was performed. The specimen was unfortunately lost. The postoperative course was uneventful with a return of visual acuity to 5/200.

The postoperative fundus examination was more satisfactory. The peripheral fundus revealed a slightly depressed disc temporally, but no nasal depression. In the temporal inferior quadrant there was an oval retinal hole about one disc-diameter long at the center of gray appearing, separated, and elevated retina. Temporally, superiorly, and inferiorly to this was a blurred gray area with irregular borders. Small vitreous opacities were present.

Consultations with the gynecological, dermatological, neurosurgical, and medical services failed to reveal any other positive physical findings.

Special data

Chest and skull X-ray studies were indeterminate.

Perimetry with a large test object (15/330) was unreliable, but indicated a concentric constriction of her field.

Tuberculin test was positive to second strength (1:1,000).

Lumbar puncture; (prone) initial pressure was 90 mm.; final pressure was 80 mm.; manometrics were normal; culture was negative; cells (spun sediment), 1; protein, 35 mg. percent; chlorides, 76 mg. percent (blood chlorides drawn at the same time were 102 mg. percent).

An audiogram (air conduction) did not reveal any hearing loss.

Initially her blood studies revealed a mild anemia which responded to an adequate diet supplemented with iron and vitamin therapy. Serologic tests were repeatedly negative (three times).

Fasting blood sugar was 86 mg. percent and 64 percent; N.P.N., 21 mg. percent; serum cholesterol, 176 mg. percent; serum titrated fatty acids, 11.1 milliequivalent.

Corrected sedimentation rate was 11 mm.; stool examination was negative for enteric pathogens and for blood (guaiac). Urine analysis was repeatedly negative. Phenolsulfonphthalein test showed 65-percent secretion in the first hour and 10-percent in the second hour with 600 cc. of urine. A 24-hour urine specimen for 17, ketosteroids was 7.4 mg. percent.

Discussion

In reviewing 29 cases of the Vogt-Koyanagi syndrome, Carrasquillo[2] observed that the symptoms were found to accompany the bilateral uveitis as follows: poliosis 82 percent; vitiligo 62 percent; alopecia (usually areata) 53 percent; dysacousia 50 percent. He believed that the association of any one of these with bilateral uveitis should be considered a Vogt-Koyanagi syndrome.

This case report presents three of these features, and is the first described with a familial history of vitiligo (paternal aunt and paternal grandfather). The history obtained indicates increased severity of the vitiligo with each succeeding generation. The present case shows involvement of over two thirds of the body surface in the past four

years plus uveal involvement. It seems pertinent to point out that vitiligo alone, with onset in middle life, has not been ascribed to heredity.

A study of the reported cases impresses me with the marked variability of the onset and course of this condition. The onset of the major symptoms was found to vary in relationship to the onset of the uveitis as follows: Vitiligo occurred from 15 years before[3] to three years after[4] the uveitis. Poliosis occurred from two years before[5] to one year after[6] the uveitis. Tinnitus and/or deafness occurred at the onset of uveitis or shortly after and usually was temporary. The uveitis may be bilateral at the onset, or involvement of the second eye may be four and one-half[7] or five years later.[4]

Cases of sympathetic ophthalmia have been reported associated with alopecia, poliosis,[8] and dysacousia.[9]

R. L. Weskamp[10] reported a case immediately following severe psychic trauma. His patient fell several meters into a deep well. He clung for a period of hours to a timber with little hope of being rescued, and certain death if he lost his tenuous hold. Immediately after he was rescued, he complained of blurred vision and tinnitus. He developed bilateral exudative uveitis with retinal separation, dysacousia, and later poliosis and alopecia.

In contrast to these cases of dissimilar onset and course, there are a significant group[11] reported with relatively rapid onset and progression of symptoms. In these, the prodromal period is sometimes characterized by clinical and laboratory findings suggestive of a low-grade encephalitis.

These marked differences in onset and progression suggest a varied etiology for the same clinical syndrome.

Hague,[11b] in a fine analysis of the reported cases as well as the individual symptoms, gives convincing support to a virus theory of etiology previously suggested by Bunge.[11h]

The similarity to Harada's disease has been previously noted[12] and a case has been reported presenting symptoms of both.[13] Those cases of Vogt-Koyanagi syndrome with prodromal symptoms of encephalitis (or "flu"), plus a rapid course (a few months) may be the same entity as Harada's disease. This is important in light of the fact that experimental work has indicated that a virus may be the etiologic agent of Harada's disease.[14] Satisfactory funduscopic examination which would help in differentiating them is often impossible due to cloudy media.

Bilateral uveitis plus one or more of the classical symptoms is rare. Its rarity almost prohibits the conception of a specific "infectious" etiology. Frequently any of the individual symptoms occur alone, and therefore may be the only presenting symptom of the rare complete syndrome. Ophthalmologists might well suspect any case of uveitis of undetermined etiology with clinical or laboratory indications of encephalitis as a potential case of this affliction.

The attempt to explain the relationship of the various symptoms on an anatomic or physiologic basis is most difficult. Hague[11b] presents evidence supporting the opinion that a hypothalamic lesion alone could produce the complete clinical picture. He stressed Vonderahe and Abrams'[15] case as clinical evidence. This case developed blindness, deafness, pigmentary changes, and canities followed by baldness associated with an ependymoma of the floor of the third ventricle. However, the cardinal sign, uveitis, did not exist in that case. The visual loss was related to tract invasion by the tumor; the hearing loss was best ascribed to pressure phenomenon; the poliosis and subsequent baldness may be related but was not of a patchy type. Since the reported change in pigmentation of the skin was one of increase, and not a decrease, the patient lacked true vitiligo.

As yet there is no reported autopsy examination of the hypothalamic area in a typical case or in patients presenting individual symptoms. However with attention now

focused on this area, the opportunity should not be missed when it presents itself.

Summary

A case is presented of a 34-year-old Negress with bilateral uveitis and retinal separation O.S., vitiligo with an hereditary background, and poliosis. This case is outstanding in view of a familial factor.

Pertinent literature is reviewed and the similarities and differences in the reported cases are brought out with respect to onset and course.

Suggestive etiologic factors are discussed.

Conclusions

1. Pigmentary disturbances and uveitis have been associated clinically.

2. No specific etiology has been demonstrated, but many have been suggested. In the case presented, an hereditary predisposition is evident.

3. Careful investigation of all patients presenting individual symptoms is indicated to facilitate a more intelligent consideration of the rare complete syndrome of Vogt-Koyanagi.

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TUBERCULOUS CHOROIDITIS ASSOCIATED WITH XANTHOMA TUBEROSUM

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Although the association of tuberculous choroiditis and xanthoma tuberosum has been infrequently reported,[1] the recognition of this combination may lead to a more logical therapeutic approach. There is also evidence that other ocular disturbances may be benefited by correction of any disorder of lipoidal metabolism.

In the case to be reported, the therapeutic response was sufficiently striking to be brought to the attention of others who may have similar cases.

CASE REPORT

History. About eight years ago, R. C., a woman, complained of blurred vision and black spots before her right eye. The onset was gradual and painless but the condition was progressive. She became unable to read with the right eye. Treatment was begun in the out-patient clinic at a New York hospital where tuberculous choroiditis was suspected.

Laboratory tests. Agglutination tests for brucellosis and the Wassermann and Kahn tests were reported as negative. However, there was a positive reponse to the Mantoux test on three separate occasions: 1943, 1:10,000 = 4+; 1944, 1:100,000 = 2+; 1948, 1:10,000 = 3+.

Following the Mantoux test in 1944, the patient suffered a severe local, focal, and systemic reaction. At this time, when she was in the last months of pregnancy, there was a large swelling on the forearm which persisted for several months after the inoculation. A break appeared in the skin, and oozing of serum continued for a week or longer. She was feverish for more than 72 hours. She felt that her right eye became much worse at that time.

The patient remained under observation and treatment at the New York hospital for several years, receiving several courses of tuberculin therapy during this period. Various notations on the hospital chart indicated that the lesion of the right eye was an old, recurrent chorioretinitis.

In 1947, "a hole in the vitreous" was described by one of the attendants, and later in that year, a note read: "Recurrent choroidal lesion temporal to the right macula." Vision at that time was: O.D., 20/70; O.S., 20/30.

In 1948, a series of injections with Cooley's vaccine was begun but an increase in the number of "spots" seen by the patient soon appeared and she stopped taking these injections.

Eye examination. I first examined this patient on March 18, 1948.

Right eye. Many small and some large keratic precipitates were disseminated throughout the entire cornea, giving it a studded appearance. Some very fine Koeppe nodules were present in the pupillary margin at the 4-, 5-, and 6-o'clock positions. The lens was clear.

There was some turbidity of the vitreous associated with an old, thin, veil-like structure lying in front of the disc, with three fine striations through which a clear view of the disc could be had. In the lower portion of the fundus, the vitreous was covered with many grayish, round opacities that resembled snowballs and appeared to lodge just in front of the retina. These opacities were fairly close together, quite round, and moved very little with the movement of the eye.

There was one large choroidal lesion, temporal to the disc. It was densely pigmented and appeared to have several areas of exudate (fig. 1-C) indicative of multiple recurrences. The vitreous exudations were most pronounced anterior to these lesions.

The disc itself appeared to be somewhat atrophic and of a peculiar fuzzy yellow.

The most striking changes, however, were those of the arteries which showed pronounced periarterial encrustation. The arteries were completely encircled with a deposit resembling boiler scale or candle tallow so that the vessels appeared almost entirely white and nodular. This (fig. 1-A) was most pronounced near the disc and faded away toward the periphery. This whiteness of the vessels was most striking.

The veins also showed many interesting changes. At several places they seemed to be engulfed by connective-tissue circles which tended to strangulate them, thus producing nodulations. These constrictions were most pronounced in the area of bifurcation of the veins and at the arteriovenous crossings.

Family history. The family history is important in this case. The mother, aged 60 years, had indications of xanthelasma, bilateral corneal scars, vitreous opacities, and multiple xanthoma tuberosum involving the fingers, knees, elbows, and tendon achillis.

An older sister had multiple recurring xanthelasma and xanthoma tuberosum of the fingers, knees, and tendon achillis. She had a blood-pressure reading of 140/105 mm. Hg and a blood cholesterol reading varying from 1,050 to 260 mg. percent.

A younger sister had two small lumps on her left elbow, one very pronounced spur on the back of her left heel, as well as a lump on her right heel. There were fatty scar-tissue areas on the front of her right leg. She had had these fatty areas on both legs but, after taking thyroid tablets for a year, one mass disappeared. She suffered severely with

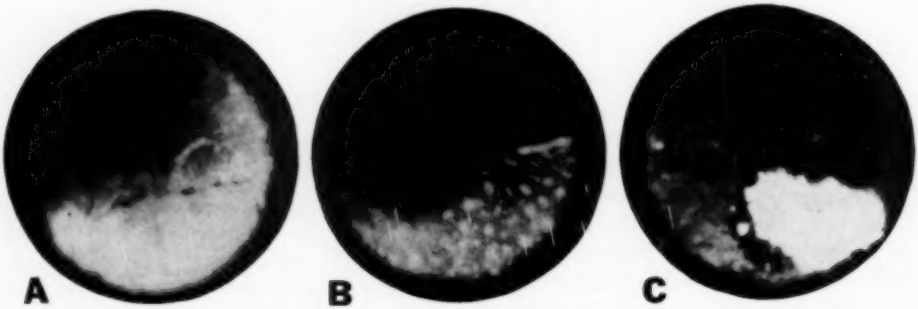

Fig. 1 (Rosen). Tuberculous choroiditis and xanthoma. (A) The arteries were encircled with a deposit resembling candle tallow. (B) Exudates overflowing from the inferior temporal vein. (C) The choroidal lesion was densely pigmented and appeared to have several areas of exudate.

menstrual pain and was confined to bed for a few days each month. The menstrual cycle occurred regularly every 26 to 28 days. With the taking of thyroid, this disturbance improved, but slightly.

One brother, who died at the age of 32 years, was supposed to have suffered from cerebral hemorrhage. His physician believed that he had a coronary xanthoma. I first saw him in 1941, at which time his blood-pressure reading was 220/120 mm. Hg. He had been hospitalized some months earlier for a possible cerebral hemorrhage secondary to high blood pressure.

Eye findings in this brother showed vision to be: R.E., 20/30; L.E., 20/25. The pupillary responses to light, accommodation, and consensually were present. The temporal portion of the right eye and nasal portion of the left eye gave a definite negative Wernicke hemianopic reaction.

Fig. 2 (Rosen). Eyeground studies of a brother of the patient showed evidence of hypertension.

The eyeground studies showed evidence of hypertension (fig. 2). The arterial tree was extremely reduced. In many places there was a loss of light reflex on the artery due to changes in the caliber of the blood vessel. The visual field study showed a symmetrical left homonymous hemianopia (fig. 3).

Because of the family history, I began to check for xanthomatosis in the patient herein reported. She had only one lump on her finger. In 1945, however, she had been investigated for xanthoma tuberosum, and it was found that her blood cholesterol was 350 mg. percent.

Routine physical examination of heart, lungs, abdomen, and extremities was negative. Blood pressure was 135/80 mm. Hg.

There was a small, soft, xanthomatous nodule on the dorsum of the proximal phalanx of the third finger of the left hand. This mass moved with the extensor tendons. A similar mass, present on the left tendon achillis, moved with that tendon and was approximately the same size as the nodule on the hand.

The ear, nose, and throat investigation revealed no pathologic condition which might possibly involve the left facial nerve. An audiogram indicated a slight hearing loss in the right ear.

The vascular clinic reported no changes in the

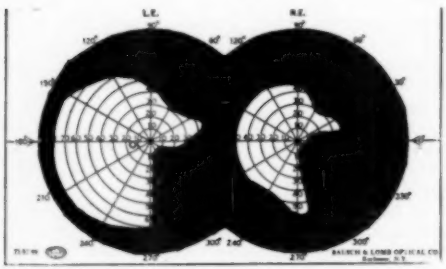

Fig. 3 (Rosen). Visual-field study of brother of the patient showed left homonymous hemianopia.

peripheral vascular structures. Complete oscillometric studies were within normal limits.

The routine allergic investigation was negative. Examination in the cardiac clinic, including electrocardiographic studies, disclosed no abnormality of the heart.

Blood chemistry showed: Proteins, 6.9; globulin, 2.2; albumin, 4.7; A.C. ratio, 2:1; N.P.N., 30. Urinalysis was negative, the basal-metabolism rate was a minus 16 percent. Wassermann and Kahn reactions were negative. The sedimentation rate was 30 per hour; W.B.C., 13,000, with 61-percent polys, 32-percent lymphs, one-percent eosins, six-percent monos.

The CO_2 combining power was 104 percent, total lipids, 1,253 mg. percent; fatty acids, 678 mg. percent; lipid phosphates, 13.2; cholesterol, 560, 410, 350, 280 mg. percent; lipase, 0.1; creatine, 7.5. mg.

X-ray studies of the skull showed no bony rarefaction. There was calcification of the pineal body. The sella turcica was normal. The sinuses were reported as negative.

A biopsy was performed upon the growth of the middle finger. The specimen was described as a lobulated nodule of pale yellowish color. The tissue covering was pearly gray and tendonlike in appearance.

The microscopic section showed a rather cellular lesion of irregular coils of spindle-shaped nuclei and hyalinized stroma. The nuclei were elongated and stained darkly. There were many polygonal-shaped foamy mononuclear cells, but no giant cells.

In April, 1948, the patient believed there was a marked visual improvement and, at this time, the white scalings of the arteries appeared to be melting away. After four weeks, very little pronounced whiteness was left along the arteries; however, there was a marked increase in the number of snowball-like exudates distributed symmetrically in the vitreous. They were uniform in size and were found mostly in the lower field.

By May, the periarterial changes continued to improve but the snowball exudates were present in increasing numbers throughout the entire lower half of the vitreous.

A most striking picture now occurred. Along the course of the inferior temporal vein, the exudates appeared to be oozing or overflowing from the vein. They looked like soft snow drifting from a clothesline (fig. 1-B).

When the patient was examined in September, 1948, the fundus seemed quite clear and the disc could now be easily seen. There was no indication of perivasculitis. There was a shiny gray crown of exudation around the macula. The nervehead was of good color. The large area of exudative choroiditis in the temporal periphery showed gradual regression.

A membrane with many perforations was seen just in front of the retina. On this membrane were small irregular areas of opalescent spherules. They were not unlike the melted-down remnants of the "snowballs" already mentioned. The membrane was best seen with the Hruby glass and Kleefeld mirror. Vision at this time was 20/50; blood cholesterol was 280 mg. percent.

Fig. 4 (Rosen) Patient's fundus appearance at last examination.

Therapy. Treatment in this case consisted of desensitization with tuberculin, animal fat-free diet, thyroid therapy, vitamin-B complex, and the use of lipotropic substances. The blood cholesterol was rapidly reduced to 280 mg. percent at which level it remained for several weeks.

At this time, Inositol (1.0 gm., three times daily) was begun. This was continued for several months and the blood lipids were checked monthly. After several months, Inositol was discontinued and choline was substituted. Since the patient did not respond well to this product, it was discontinued after two weeks and Inositol was again given. In a very short time, the patient felt better and the blood lipids soon returned to the original level.

At the last examination, vision in the involved eye (fig. 4) could be improved to 20/30. There were few residual vitreous changes. The chorioretinal lesion did not show any signs of recent activity. Beginning September 20, 1949, the patient was permitted to eat all varieties of food. To date there has been no systemic or ocular disturbance.

Discussion

The occurrence of tuberculous choroiditis in a patient with familial hypercholesteremic xanthomatosis has rarely been described. Thannhauser[1] reports the case of a 30-year-old physician who suffered from a dissemi-

nated chorioretinitis. A thorough search revealed no definite etiology.

After reading this case report, I wrote to Dr. Thannhauser who replied that it was his impression that the chorioretinitis in his case was incidental and had nothing to do with the xanthomatosis and that, in all cases of xanthomatosis he had seen, there was no associated chorioretinitis.

In the case herein reported, the massive snowball-like exudation into the vitreous closely resembled, biomicroscopically, asteroid hyalitis, chemical studies of which have disclosed the presence of abnormal cholesterol crystals. This suggests the need to study the lipid metabolism in all cases of asteroid hyalitis and related vitreous abnormalities.

Recently[2] there has been found a striking relationship between the blood cholesterol and such conditions as arcus juvenilis, virus encephalitis, pingueculas, and drusen of the macula, as well as in asteroid hyalitis. The eye, therefore, cannot be excluded from the possibility of being affected by disorders of lipid metabolism.

Thannhauser has emphasized that, if the cholesterol content is more than 300 mg. percent and if xanthoma planum, no matter how small, is observed, it may be assumed that other organs are involved simultaneously. He believes that the blood vessels, especially the coronaries, may be involved.

Canton's[3] demonstration that arcus senilis is due to a deposit of fatty droplets in the cornea has led to a better understanding of this condition. Four of the five members of the family in the case herein reported were examined biomicroscopically. In none, however, was there any evidence of arcus senilis.

Loewenstein,[4] in his studies of the lipid pathology of ocular tissues, has stated: "Fatty substances are not present in normal young ocular tissue. The senile or pathologic ocular tissue only stores fat." He has shown that hypercholesteremia exists in arcus juvenilis and believes that the arcus is due to fat from the blood stream; that in old age there is normally an arcus because the metabolism of senile corneal tissue is not sufficiently active to oxidize the normally offered fat in this area.

The appearance of the fundus of the patient herein reported in March, 1948, calls to mind the findings in tuberculous periarteritis.

Elwyn[5] refers to a case reported by Kyrilies[6] in which the arteries were covered by white wings, especially at the bifurcational points. Kyrilies regarded his case as a local allergic reaction of the blood-vessel walls to the presence of tuberculotoxin in the blood stream, and his explanation would seem to be applicable in the present case.

Muncaster and Allen[7] report a woman, aged 31 years, who developed a severe reaction to 0.005 purified protein derivative (tuberculin) and, three weeks later, presented a pronounced periarteritis near the disc. This disappeared in three months. The entire retina presented a yellowish appearance.

It is conceivable that, in my patient, during an infectious process, the abnormal lipid substances may have acted as an immunologic stimulus and produced a much greater response than would have occurred under normal conditions. This phenomenon has been shown to be prevalent and is the basis for the adjuvant technique of Freund and McDermott.[8]

The work of Morrison[9] on the effect of lecithinase upon the central nervous system in experimental encephalomyelitis suggests more than a casual relationship between cholesterol and vitreous exudate in this patient. The presence of a hole in the posterior hyaloid membrane, as seen in my case, has been the subject of some controversial reports.

Anderson[10] thought such a membrane could result from some obscure degeneration or inflammation.

Vogt and Stahli[11] stated that a central aperture due to separation of vitreous from

the optic nerve was common in myopia and senility.

Goldstein[12] described a circular retinal hole associated with a patch of choroiditis corresponding in size to the hole.

According to Knapp[13] "sometimes a band of opacity remains which extends from the nervehead to the area of choroidal atrophy." The vitreous is clear except for this opacity which is situated in front of the retina and seems to have a predilection for the macula. It always covers the blood vessels and newly formed capillaries are never observed to penetrate the opacity (membrane).

In a tuberculin-sensitive individual, capable of reacting tenfold to a stimulus, the presence of any associated xanthomatous lesion should cause the ophthalmologist to examine further for any complications that may be due to disturbances of the lipoidal metabolism.

692 High Street.

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CATARACTS AND RETINOPATHY IN JUVENILE DIABETICS*

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This report is based on a study of the juvenile diabetics who are being followed in the Diabetic Clinic at the Harriet Lane Home of The Johns Hopkins Hospital. This clinic has been in existence for 21 years. All of the patients in this clinic developed diabetes mellitus before the age of 13 years. While some selection may be represented by the group under discussion, since most of the patients have been checked in the clinic at regular intervals, there are enough patients whose coöperation has been lax to afford a fair cross-section of diabetes of all degrees of regulation.

Material

At the Harriet Lane Home, 67 juvenile diabetics are being followed at the present time. On all of these information is available concerning blood pressure, complete urinalysis, kidney function as measured by the phenolsulfonphthalein test and the blood nonprotein nitrogen, and the presence or absence of X-ray evidence of arteriosclerosis in the peripheral vessels.

* From the Departments of Ophthalmology and Pediatrics of The Johns Hopkins University and Hospital.

There are records showing the extent of the control of the diabetes and, in all cases, the evaluation of the control has been determined by pediatricians long familiar with each individual patient.

All of the children have received insulin regularly after their admission to the clinic. Early in the course of the diabetes, regular or crystalline insulin has been used while protamine zinc insulin has been added as the progress of the diabetes demanded.

The dietary management of these children might be interpreted as strict, with a generous but calculated carbohydrate allowance. Weighed diets are the rule in new patients with a shift to measured quantities as familiarity with the diet and the disease develops. Considerable freedom is permitted in making substitutions and in daily variations in quantity (without measurement) of foods with low-available carbohydrate content.

Each patient has been given a control rating of either poor, fair, or good.

A patient is considered to be poorly controlled if he has disregarded his diet, has shown ketosis frequently, and has not infrequently required hospitalization because of acidosis. A child with a fair rating is one who has followed his diet at least part of the time, and who has rarely required hospitalization for acidosis in spite of a marked glycosuria on most examinations. A good control rating indicates that the child has followed his diet well for the most part, has rarely shown glycosuria exceeding 10 gm./24 hours when on crystalline insulin therapy and 20 gm./24 hours on a combined protamine crystalline regimen, and has been hospitalized because of acidosis only under circumstances beyond his control.

If, over a period of years, control has changed from one classification to another, this fact also has been taken into consideration. The availability of information concerning the control of patients over a long period is one of the factors which prompted this study. In many of the published reports dealing with ocular changes in juvenile diabetics the control of the diabetic status is unknown or not mentioned.

In 61 of the 67 patients it has been possible to examine the eyes under mydriasis with the slitlamp and the ophthalmoscope. In some cases the eyes have been reëxamined after an interval of approximately one year; 37 of the patients whose eyes were examined have had their diabetes for less than 10 years; 24 have had their diabetes for 10 years or longer; 22 years is the longest period that any of the patients in this series have suffered from diabetes.

All of the patients in the group having diabetes for 10 years or more require at least 32 units of insulin daily. The maximum daily dose is 106 units. In the over-10-years group, the youngest patient is aged 12 years and the oldest is 27 years of age.

In general, the physical findings and auxiliary studies, except for the diabetic status, are within normal limits on the 24 juvenile diabetics who have had the disease for longer than 10 years. Only one patient shows X-ray evidence of arteriosclerosis of the peripheral vessels. The blood pressure is within normal limits in all except two and, in these two, the blood pressure is only slightly elevated. Kidney function as measured by the phenolsulfonphthalein test and determination of the blood nonprotein nitrogen level is normal in all cases. Albuminuria in small amounts is inconstantly present in only three of the patients. In summary the only disease which is present in all of these children is diabetes mellitus.

Cataracts

Diabetes in juveniles causes two general types of cataract. In both types the cataract is bilateral, although in one eye the opacity may be more advanced than in the other. In one type numerous fine punctate white opacities are found in the anterior and posterior cortex close to but not immediately beneath

the capsule. The punctate opacities are referred to as flocculi by some authors and as snowflakes by others. In some cases iridescent crystals are associated with the flocculi.

The other common type of cataract is a posterior saucer-shaped subcapsular opacity composed of confluent granules. The two types of opacity may be present in the same lens.

Although these two types of cataract develop over a period of months, it is also apparent from the literature that, under conditions of poor control, a cataract may develop rapidly in a matter of weeks or less in a young diabetic and by rigorous therapy these rapidly developing opacities may be greatly reduced or eliminated completely.

For example, Alt[1] reported a young diabetic woman under poor control who developed bilateral lenticular opacities in one day and after faithfully following her diet the opacities disappeared in a matter of weeks. Fischer[2] presented a 17-year-old patient with severe diabetes and bilateral posterior cortical opacities whose cataracts decreased markedly after careful therapy with insulin. Braun[3] had a 16-year-old patient with severe diabetes and bilateral cataracts and, after rigorous insulin treatment, the lenticular opacities disappeared entirely and the vision returned to normal.

In 1934, O'Brien, Molsberry, and Allen[4] published a report based on the study of 126 diabetic patients whose ages ranged up to 33 years; 20 patients, an incidence of 16 percent, had diabetic types of cataract. Severe, prolonged, poorly controlled diabetes was present in all but two of the 20 cases.

In 1942, O'Brien and Allen[5] presented the results of their examination of 260 diabetic children under 21 years of age; 36 patients, an incidence of 13.8 percent, had diabetic lens changes. In each case in which a diabetic cataract was found, the diabetes was poorly controlled or uncontrolled for several months or years preceding the development of the opacities. These authors also reported the arrested development of lenticular opacities after six months of strict control.

Waite and Beetham[6] included in their monumental report their observations on 297 diabetics under the age of 20 years. They found that 11 patients or nearly four percent showed diabetic cataracts. All of the patients with lenticular changes were severe diabetics with heavy insulin requirement. Approximately half of their cataractous patients were poorly controlled at the time of their first examination and, in the remainder, the typical opacities appeared and multiplied in spite of the most satisfactory control of the diabetes.

Priscilla White[7] in her chapter on juvenile diabetes states that cataracts were identified in 31 of 2,191 cases, an incidence of 1.4 percent. In addition she writes that most of the cataracts occur early in the disease and are rarely first diagnosed after five years of diabetes. In support of this is the fact that cataracts were found in only 1.6 percent of the patients who had had their diabetes for 20 or more years, practically the same percentage as was found among her total number of juvenile diabetics. She further mentions that it is her impression that the development of cataracts in these patients is correlated with poor control of the disease.

In 1947, Givner and Lodyjensky[8] examined a group of 128 children, between five and 19 years of age, with diabetes and found typical bilateral opacities in one case, an incidence of 0.8 percent. The children whom they examined were practically all under insulin therapy but the state of control of the diabetes is not mentioned.

In our total series of 61 juvenile diabetics whose eyes were examined, no diabetic cataracts were found. Our patients, in general, probably represent a group maintaining better-than-average control of their diabetes.

From a study of the literature already mentioned, there is no evidence that, among juvenile diabetics, typical cataracts increase in frequency with the duration of the dia-

betic condition. It would seem, moreover, that with more rigorous control of the diabetic status there is a reduction in the incidence of cataracts in juvenile diabetics. Our material tends to strengthen this impression.

Retinopathy

As seen with the ophthalmoscope, diabetic retinopathy is characterized by deep punctate "hemorrhages" and waxy exudates. Ballantyne and Loewenstein,[9] by examining the fundi at autopsy with a slitlamp and by studying flat sections of the unstained retina with a microscope, were the first to discover that the deep punctate "hemorrhages" were, in fact, capillary aneurysms.

Friedenwald[10] employing the Hotchkiss-McManus technique to stain the basement membrane surrounding the endothelium of the retinal vascular tree was able to confirm and extend the findings of Ballantyne and Loewenstein.

In 1945, Ballantyne[11] wrote that, in his opinion, these microaneurysms seen ophthalmoscopically singly or in small numbers within or near the macular area were the earliest unequivocal sign of diabetes.

To this might be added that, in some cases, varicose dilatations of the capillaries in the macular region rather than characteristic sacular aneurysms are found. In addition to the aneurysms, true hemorrhages which in general are larger and less discrete may be found either in the region of aneurysms or elsewhere in the fundus.

The exudates are small, irregular, and hard in appearance, and usually are near the posterior pole but may be found elsewhere usually with aneurysms in the same area.

Other findings in juvenile diabetics include venous changes such as localized dilatations of a vein, newly formed retinal capillaries, and retinitis proliferans.

In a paper published in 1941, McKee[12] reported that of 96 patients ranging in age from six years to and including 31 years, three showed diabetic retinopathy, an incidence of three percent. The severity or control of the diabetes was not mentioned.

O'Brien and Allen[5] found 23 cases of diabetic retinopathy in a survey of the fundi of 555 diabetic patients under the age of 31 years. Diabetic retinopathy, therefore, was present in four percent of their cases and the control of the diabetes in the 23 cases varied from fair to none.

Priscilla White[7] found small, round, deep retinal hemorrhages near the disc in approximately six percent of her total juvenile diabetics. However, retinal hemorrhages were found in 65 percent of the children examined who had survived 20 or more years of diabetes. The degree of control of the diabetes is not mentioned.

Givner and Lodyjensky[8] found that two percent or three of the 128 children whom they examined had retinal changes characteristic of diabetic retinopathy. The youngest child with retinopathy was 12 years of age and had had diabetes for eight years. Two of the three patients showed some albumin in the urine.

Daeschner, Deisher, and Hartmann[13] in a follow-up study of juvenile diabetics found that 53 percent of the patients they examined had diabetic retinopathy. Their patients had had diabetes for periods ranging from seven to 28 years and the control of the diabetes varied. In their series no patient with diabetes of less than 15 years' duration had advanced retinopathy.

Post and Stickle,[14] using the same material as Hartmann and his associates, correlated the duration of the diabetes with the control and concluded that poor control, as well as the duration of the disease, was an important factor in the development of retinopathy.

Results

In our series, the ophthalmoscopic findings are classified somewhat as they were by Daeschner, Deisher, and Hartmann. There are four classifications: (1) Normal; (2)

Grade I (minimal retinopathy)—1 to 20 microaneurysms and/or 1 to 10 exudates per fundus; (3) Grade II (moderate retinopathy)—20 or more microaneurysms, the presence of retinal hemorrhages, and/or 10 or more exudates per fundus; (4) Grade III (advanced retinopathy)—the above plus the presence of new retinal capillaries, retinitis proliferans and its complications.

Each fundus of any designated patient almost invariably falls in the same classification. Occasionally a patient with minimal retinopathy in one eye will have a normal fundus in the other eye.

Reëxamination also shows that the aneurysms can completely disappear. Eyes with early retinopathy in our series almost always have more aneurysms than exudates. Rarely, however, a fundus with minimal retinopathy is found with more exudates than aneurysms.

Among the 37 patients who had had their diabetes for less than 10 years, there were two with retinopathy. Both had Grade-I retinopathy and, except for their diabetes, were normal on physical examination. One patient had had diabetes for six years and the other for nine years. Control of the diabetes was considered fair in one and good in the other.

The incidence of diabetic retinopathy among juvenile diabetics in our series who had had the disease less than 10 years approximates the two percent found by Givner and Lodyjensky when examining diabetic children the majority of whom had had their diabetes for 10 years or less.

Among the 24 patients who had had their diabetes for 10 years or longer, there were 13 patients with diabetic retinopathy. For the distribution of the fundi of these patients among the various grades see Table 1.

The incidence of diabetic retinopathy in the patients who had had diabetes for 10 years or more is in extremely close agreement with the 53 percent reported by Daeschner, Deisher, and Hartmann. These figures are exceeded in the literature previously discussed only by the 65 percent reported by Priscilla White. This percentage, however, occurred in children who had survived 20 or more years of diabetes. It seems evident that the duration of the diabetes plays the fundamental role in the development of retinopathy in juvenile diabetics.

TABLE 1

DISTRIBUTION OF THE FUNDI BY GRADES

Normal	24
Grade I	18
Grade II	2
Grade III	4
Total No. of Eyes	48

The effect of control of the diabetic status on the development of retinopathy is more difficult to determine. Our series is too small to permit a statistical determination of the effect of control upon the occurrence of retinopathy. To complicate the matter further an occasional patient during the long period of follow-up changes from one control classification to another.

As would be expected from our criteria of control the great majority of our patients are classified as good or fair. The normal fundi have been found only in those with good and fair control.

Grade-I fundi have been found in all three control categories. Grade-II fundi were found only in patients with poor control.

Grade-III fundi existed in two patients. One patient is a 24-year-old man who has had diabetes for 21 years, with an insulin requirement of 85 units daily and fair control. The other is a 25-year-old woman who has had diabetes for 16 years and requires 104 units of insulin daily. Her control was poor during the first eight years of her diabetes but good during the second eight years. During the past year, while her control was good, her retinopathy has changed from a Grade-I to a Grade-III classification.

This group of patients, all of whom have had their diabetes for more than 10 years

and all of whom require relatively large amounts of insulin must be observed over a longer period to determine the effect of control upon the development of retinopathy. It is hoped that follow-up studies on the material presented here and similar studies on other groups will supply the answer to the problem concerning the influence of the control of diabetes upon the development of retinopathy in juvenile diabetics.

Conclusions

Careful regulation of the disease in juvenile patients with diabetes mellitus undoubtedly reduces the incidence of cataracts. As far as retinopathy is concerned the duration of the diabetes is paramount in the development of characteristic retinal lesions.

The Johns Hopkins Hospital (5).

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Ophthalmic Miniature

In the retina (case of diabetic retinopathy, Ed.) there are minute aneurysms on the capillaries. These are not very abundant, they often occur in little groups of about half a dozen or less near together, large adjoining tracts being quite free from them. They are globular pouches, apparently communicating with only one side of the vessel; never fusiform dilatations. They usually contain some reddish-brown granules, and sometimes similar granules are seen lying in the tissue just external to them, suggesting that the bleeding into the vitreous may have been due to the consecutive rupture of a number of chambers.

Edward Nettleship, *Ophth. Hosp. Reports*, **9**:152, 1879.

NOTES, CASES, INSTRUMENTS

XANTHOMA OF THE IRIS*

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Xanthomatous involvement of the iris has not, to our knowledge, been reported in the literature. The following case is suggestive of this diagnosis.

G. C., a white man, aged 26 years, reported to the eye department of The Monroe Clinic on May 24, 1947, for treatment of a bee-sting on the right lower eyelid. There was no history of previous trauma. The patient had noticed a yellow spot in his left eye for the past two years which seemed to be getting larger. A detailed eye examination was performed within a few days after the right eye had healed.

The corrected vision was: R.E., 20/20−2; L.E., 20/20−2.

Examination of the eyes showed the right eye to be normal throughout. The left eye presented a pale-yellow, slightly elevated discoid mass, approximately two mm. in diameter, which was located in the ciliary zone of the iris in the 5-o'clock position. The angle of the iris appeared to be quite shallow in this region.

The mass did not appear to extend into the pupillary zone of the iris, but a small ectropion of the uvea was present on the pupillary border of the iris in the region of the tumor mass.

Examination of the lesion with the slit-lamp microscope showed the lesion to be avascular and to contain very little uveal pigment. In addition to the iris lesion, a small pigmented nevus was located in the conjunctiva near the limbus of the cornea in the 4-o'clock position.

The pupils were equal in size and reacted normally to both light and accommodation. The refractive media were clear and the fundus was normal throughout.

The intraocular pressure of the right eye was 17 mm. Hg (Schiøtz); that of the left eye, 19 mm. Hg (Schiøtz). Transillumination of the globe was normal. Perimetric studies were normal throughout.

General medical examination was essentially negative and revealed no other tumor masses or abnormal pigmentation.

Laboratory studies revealed a normal blood count, and the urine analysis was negative. The fasting blood sugar was 109 mg. percent. The glucose tolerance test was normal. The blood cholesterol level was 152 mg. percent.

The possibility of a malignant tumor of the iris was considered, and on May 28, 1949, the lesion was removed by means of a broad based iridectomy. The mass was not

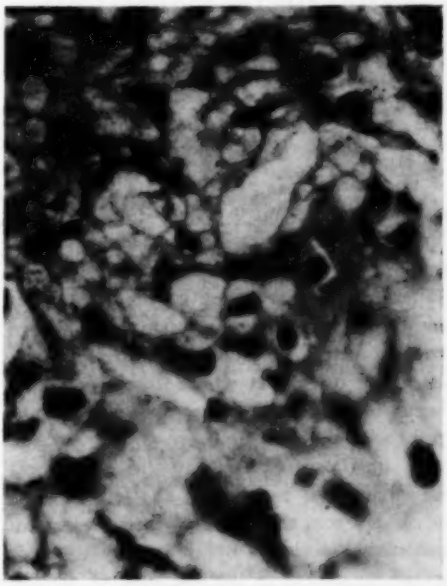

Fig. 1 (Mings and Kundert). Photomicrograph, showing foam cells.

* From the Department of Ophthalmology, The Monroe Clinic.

The photomicrograph of a portion of one of the slides was made by Dr. Michael Hogan of the University of California, San Francisco.

attached to adjacent tissues and was easily removed. The lesion consisted of a hemispherical nodule, the posterior surface of which was quite convex and covered by dark-brown uveal tissue. The eye healed without complications.

The tumor mass was sent to the Army Institute of Pathology, and the following is a microscopic description by Mrs. Helenor Campbell Wilder:

Gross: The specimen consists of a tan nodule measuring 5 by 3 by 2.5 mm. One surface is deeply pigmented.

Microscopic: In one area, foam cells are closely packed in the iris extending from the anterior margin to the pigment epithelium. Elsewhere at the anterior surface there are hyperchromatic and multinucleated cells, sometimes with vacuolated nuclei.

There has been no recurrence of the tumor in or about the eye, and the corrected vision was 20/20−2 at the time of the patient's most recent examination in December, 1950.

SYMPATHETIC OPHTHALMIA

Report of a case with spontaneous recovery

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The patient, a man, aged 41 years, was chopping wood on April 6, 1949, when a large splinter struck his left eye. He was immediately treated by an oculist, who repaired a large laceration of the sclera over the nasal ciliary region. Healing progressed without cause for alarm until three weeks after the injury, at which time the patient began to experience difficulty in reading fine print with the uninjured eye.

A diagnosis of sympathetic ophthalmia was made and removal of the left eye was advised. From this point onward the patient consulted a series of ophthalmologists, all of whom concurred in the diagnosis of sympathetic ophthalmia; with one exception, they also insisted on the enucleation of the left eye.

I first saw the patient on May 16, 1949. At this examination the left eye presented a well-repaired laceration of the sclera nasal to the limbus. A large operative coloboma of the iris was evident in the horizontal meridian nasally. The eye was white and painless. There were numerous deposits on the posterior corneal surface, Koeppe nodules on the iris margins, and numerous cells were revealed in the aqueous circulation.

The tension was normal. The corrected vision was 20/50 plus. Conspicuous was the presence of an excessive amount of black pigment diffused over the entire nasal half of the globe; the intensity of pigmentation and the extent of discoloration were far beyond the degree one would expect after a perforating wound.

The right eye was also white and painless but there were numerous posterior corneal deposits and cells in the aqueous. The tension was normal. The visual acuity was 20/20.

The patient obviously was searching for moral encouragement in his decision to retain his eye. At this stage it was clear that the patient's instinct had been truer than his medical advice, and that nothing was to be gained by enucleation.

The man was hospitalized, and the usual treatment was instituted: salicylates, milk injections, typhoid vaccine, aureomycin, streptomycin, penicillin. At the end of 12 days it was considered safe to dismiss the patient to his home in Canada, where similar therapy could be continued. There was little perceptible improvement in the clinical picture but, more significantly, the condition definitely was not worse. It was felt that the process had burnt itself out and that future changes would be in the direction of recovery.

This optimism was justified by the subsequent course of the illness. The patient re-

turned on November 20, 1950, about a year and a half later. Both eyes were white, deposits and cells had disappeared from the corneas and aqueous. The vision in the right eye was 20/20, in the left, 20/30. The pigment over the nasal half of the left eye was still present but it had become absorbed in large measure.

Comment

This case is deemed worthy of record because of several features. The onset of sympathetic ophthalmia occurred very quickly; a three weeks' interval is an unusually short period. The profusion of pigment in the region of the wound was beyond the expected amount and indicated an active proliferation of pigment rather than a passive diffusion from the adjacent pigment cells. One might bear this observation in mind in relation to the theory of pigment sensitivity in sympathetic ophthalmia.

Sympathetic ophthalmia is usually physiologically fatal to both eyes. Exceptions, however, occur, as illustrated by this instance. There are various intensities of this disease, and a rare case will recover completely by virtue of the natural reparative elements of the body. I cannot attribute the happy ending to treatments which have been uniformly unsuccessful in the history of this disease. If any new medicament, such as cortisone, had been employed, one might have been misled into an erroneous conclusion.

It might be profitable to repeat the following rules as laid down by Ramsay:

"1. *Enucleate at once:* when the injury is so severe that the exciting eye is destroyed hopelessly from the beginning.

"2. *Enucleate at once:* on the slightest sign of sympathetic irritation, should the vision of the exciting eye amount to only a perception of light and darkness.

"3. *Enucleate at once:* if a foreign body is present in, and cannot be removed from, the exciting eye, more especially if the eye is tender on pressure and inflamed.

"4. *Enucleate at once:* when an injured eye is blind and suffering from concurrent attacks of acute inflammation; or when it is tender and irritable as a result of the onset of degenerative changes, e.g. ossification of the choroid.

"5. *Do not enucleate:* when there is still sight in the injured eye and when there is no sign of sympathetic disturbance in its fellow.

"6. *Do not enucleate:* when sympathetic inflammation is in progress, and there is still sight in the injured eye; for under these circumstances the removal of the "exciter" will have no beneficial influence, and the probability is that in the end all the sight the patient will possess will be in the primarily injured eye."

160 West 73rd Street (23).

INDUCED PULSATIONS IN THE CENTRAL RETINAL ARTERY OF CARDIAC PATIENTS*

J. Lijó Pavía, M.D.
Buenos Aires, Argentina

(Translated by Ray. K. Daily, M.D., Houston, Texas)

The application of cinematography to the recording of the dynamic processes in the fundus solved the difficult problem of recording the vascular processes in the fundus, arterial or venous, spontaneous or induced.[1]

This presentation is limited to the arterial pulsation induced by a constant pressure maintained on the eyeball, until the appearance of an arterial contraction simultaneously with the cardiac diastole, followed by a dilatation of the vessel in systole.[2]

The contraction of the central retinal artery during diastole takes the form of a rapid active movement; the arterial dilata-

* A beautiful cinema recording was included with this paper. It is regretted that it could not be satisfactorily reproduced in the Journal.

tion, which follows during systole, is always of longer duration than the preceding contraction.[3,4]

I have reported that, in subjects without grave cardiac disturbance, the type of the arterial pulsation is constant.[5] It is reasonable to assume that, in patients with wide differences in the blood-pressure range, such as occur in diseases characterized by the existence of an arterial dance, there will probably be found changes in the induced arterial retinal pulse.[6]

With that in mind I submitted my cinematographic films to cardiologists, and I am quoting a very interesting comment:

"In color cinematography of the arterial retinal pulsation I was especially impressed by the violence with which the artery empties itself, giving the impression of an active muscular process, and not of a passive collapse produced by the elasticity of the arterial wall. The expression 'peripheral heart' acquires real significance as one looks upon the film of the fundus. One has the impression of a ventricle actively contracting, and letting itself be filled passively, just as it occurs in the heart."

This observation is in agreement with the studies of Marceau[7] on the physiology of the arteries. He discovered new, as yet unknown, properties of the arterial wall. Of interest in this connection is the rapid contractile wave, produced by the cardiac contraction, which he described. The passage of a pulsating wave of cardiac origin produces an arterial distension, to which the artery responds by a contraction of its smooth muscle, which has such force that it is described as a "peripheral heart."

Milne, Edwards, Poisenille, Bell and Magendie recognize this phenomenon as an active rapid contraction.

Applying Marceau's findings to my cinematographic record of the pulsations of the central retinal artery, I confirmed a distinct difference in the duration of the two phases: contraction and dilatation.

Taking 10 as a unit of time for the duration of the two phases, Marceau found that the contraction lasts 6.5 and the distension or dilatation 3.5.

The cinematographic documentation of the pulse of the central retinal artery demonstrates to the contrary, that the duration of the contraction is shorter than that of the dilatation.

In patients with normal blood pressure the contraction lasts 2.5, and the dilatation about 7.5, the proportion thus being 1:3.

In general hypertension the relation between the contraction and dilatation ranges from contraction 4 and dilatation 6, to contraction 3.33 and dilatation 6.66; the proportions thus being 1:1.5, and 1:2.

In the available literature I have not found any publication on the subject of the complex relation of the two phases of the induced arterial pulsation, except for Bonnet's interesting report[8] on the prolonged contraction period (almost three seconds) in a case of Stokes-Adams disease. His article inspired this study which is presented as a preliminary communication.

Avenida Quintana 104.

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APPLICATION OF DIRECT SUTURES IN CORNEAL GRAFTING*

C. C. Teng, M.D., and H. M. Katzin, M.D.
New York

The direct suture method in corneal grafting is becoming increasingly important, especially since large grafts are now more commonly performed. Direct suturing of grafts for the nonpenetrating, lamellar keratoplasty is comparatively easy, but the penetrating graft presents considerable technical difficulty. We believe there are several suggestions in technique that are worth presenting.

The first stitch in the graft is always the most difficult because there is no counter traction and the graft tends to rotate as the needle is passed. Successive stitches are easier.

In order to facilitate the introduction of the first stitch, the graft is laid, endothelium down, on a piece of cork. This gives sufficient counter support. The cork is sterilized and draped separately with a drape that has a hole which fits around it. This is prepared with four cutting needles piercing the cork in convenient positions.

The graft is removed from the donor eye with a trephine in the usual fashion and placed on the cork.

Each needle is introduced without forceps with its point perpendicular, until it has reached sufficient depth, then the point is redirected to emerge just above the Descemet's membrane. It is possible to feel the resistance of Descemet's membrane as soon as the tip of the needle touches it.

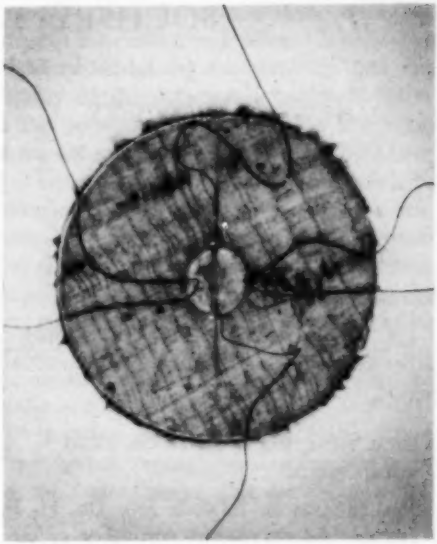

Fig. 1 (Teng and Katzin). Application of direct sutures in corneal grafting.

At first the graft is fixed to the cork by introduction of the needles into it. After all four needles are in position, the stitches are completed. The prepared cornea is now ready to be placed on the recipient eye.

In introducing the needle into the patient's cornea, the lip of the cornea of the recipient's eye should be everted with a fine fixation forceps or Hess type of iris forceps. The needle should enter at a point just above Descemet's membrane. After the four stitches have been completed, subsequent sutures can be added with ease.

When this method is employed with human corneas, the concavity of the endothelial surface prevents contact with the cork, except at the edge. Thus there is no significant trauma to the endothelium.

210 East 64th Street (21).

* This work was done under auspices of The Eye Bank for Sight Restoration, Inc.

SOCIETY PROCEEDINGS

Edited by DONALD J. LYLE, M.D.

NEW YORK SOCIETY FOR CLINICAL OPHTHALMOLOGY

March 5, 1951

DR. SAMUEL GARTNER, *president*

REFRACTION IN APHAKIA

DR. BENJAMIN FRIEDMAN presented a paper on this subject during the instruction period.

VISUAL FUNCTION IN PERIMETRICALLY BLIND FIELDS

DR. MORRIS B. BENDER AND DR. H. P. KRIEGER said that when perimetry or tangent-screen examination show an homonymous hemianopia, it implies a complete loss of vision in the anopic region. This implication, however, is valid only for the conditions under which the visual examination was performed—namely, proper illumination, appropriate targets, and so forth. By altering the conditions of examination, such as reducing the background illumination, it is possible to demonstrate some visual function in these so-called blind regions.

Eleven patients with various types of field defects were studied. In addition, 10 patients were examined with battle injuries in the parieto-occipital region. There were no apparent retinal lesions. The visual-field defects, hemianopia or scotomas, were demonstrated in the usual manner with a one-degree white target at the distance of 330 mm. under seven foot-candles of illumination.

Following this, the patient was examined in a totally dark room. The only sources of light were just a visible, tiny, red fixation point and a luminous target. The target was light transmitted through milk glass. This target was usually exposed for 0.04 of a second and it subtended between 20 feet and six degrees of visual angle. The target could be placed at any point in the visual field, while its intensity could be varied over a range greater than that of normal dark adaptation.

The head was immobilized, one eye was covered while the other was tested. Precautions were taken to eliminate extraneous clues. Thus the target was presented against a homogeneous black, nonreflecting field in a dark room.

The results of these studies can be described under five headings: (1) perception of the target, (2) subjective visual experiences, (3) localization of the target, (4) perception of flicker, and (5) threshold determinations via dark adaptation.

In complete darkness, it was found that all of the group of 11 patients could perceive the luminous target within the same regions which appeared blind upon perimetry under daylight illumination. This perception was limited to an awareness of light of an indefinite form and usually of a dim, whitish color; this ability varied with the degree of darkness of the room. Thus, the darker the room the easier it was to perceive the target, while the lighter the room, the harder it was to see.

The ability to see the target within the blind field was found to fluctuate in all cases. Thus, even after allowing enough time for dark adaptation to occur, a continuously exposed target of threshold value might subjectively disappear, only to reappear spontaneously. There was no apparent regularity to this fluctuation. Compared to the nondefective visual fields, this fluctuation was greater in degree and frequency of occurrence.

In respect to form vision, for the most part the target was perceived as a locus of light which imperceptibly faded into darkness and had no definite shape. The ability

to locate the target was tested in two ways: first, by having the patient place the tip of the index finger on the target, and, second, by having him estimate the direction and distance the target was removed from the fixation point. The patients were found to be able to localize accurately the source of light within their defective fields and to make judgements of relative distance between the fixation point and the target within these fields.

In addition to perceiving and localizing the target, it was also found that the patients could distinguish between a steady and a flickering light and that they could tell the difference between the presence of one or two targets within the defective area.

The flicker perception was markedly affected by the previously described fluctuation in the visual threshold of the so-called anopic regions and also by what were apparently persistent after-images. Thus it was found that, whereas in a normal field it was possible to determine the critical flicker frequency, there was such fluctuation in the abnormal areas that this threshold could only be estimated.

Thus far the observations indicated that visual function was present in defective fields. The next step was to show that the visual threshold could be determined in these areas. The method used was the dark-adaptation technique of Selig Hecht. In essence, this method measured serially the changes in the absolute visual threshold as the patient became dark adapted.

In these experiments, the patient was light adapted with a source of illumination known to be capable of bleaching all the visual purple in the eye. Immediately thereafter, the room was completely darkened and the threshold for light was determined many times over a period of about 40 minutes for one given point in the visual field. The target was transmitted light exposed for 0.04 second. It was 2.5 degrees of retinal angle and was fixed at 27 cm. from the patient's eye. The rest of the conditions were like those of the qualitative studies.

Before discussing the resulting data, the validity of the data was considered. There is the possibility that the vision attributed to the defective pathways is transmitted over the intact pathways as the result of light stimulus reaching the intact retina via entoptic stray light or retinal neural interaction. In this case, it is a question of whether these two factors can account for the observation that the target was perceived at 90 degrees from the fixation point along the horizontal meridian of the defective visual field.

A number of observations indicate that stray light or retinal neural interaction were not the factors responsible for seeing in the defective regions.

Firstly, the target within the defective field could be accurately localized, implying that the stimulus fell on the retina in the normal fashion and was projected into space as usual. If the sensation was mediated via the intact pathways, the target would be mislocalized to the opposite or normal region of the field of vision.

Secondly, the target was correctly localized by a patient who had almost complete bilateral hemianopia. Here stray light and neural interaction could not be the factors enabling vision in the defective regions. It might also be suspected that light passing through the sclera and stimulating the intact system might give rise to the visual sensations found. If this were so, once more mislocalization would be expected.

Thirdly, it was observed that the 2.5 degree target could be seen within a scotoma of five to nine degrees in width. The threshold within this scotoma was high, whereas to either side of the scotoma it was relatively normal. Apparently, under the conditions of the work, the areas affected by entoptic stray light and retinal neural interaction were so small that regions five degrees from the center of the retinal image were not ap-

preciably affected by these factors.

Fourthly, in those cases which recovered, the improvement in visual threshold as measured by dark-adaptation technique and the recovery on perimetric testing were simultaneous, indicating that the defective areas were functioning to some degree at all times.

Despite all these observations, the available evidence for excluding stray light and neural interaction is not conclusive. Another investigator, Dr. Battersby, using a two-degree target, projected through a long tube which almost touched the cornea, found that these same patients seemed to see even in the blindspot of the defective field. However, it cannot be stated with certainty that the blindspot was actually tested. If it were, these studies would show that stray light or neural interaction were significant.

Most significant is that more recent investigations of 10 patients with parieto-occipital brain injuries showed that five patients could and five could not appreciate light in the hemianopic area. The fact that some did not see in the blind field would seem to indicate that stray light or neural interaction was not responsible. If this were so, then all patients should see the target.

A possible functional meaning of the threshold difference between the normal and abnormal areas comes from comparison of these observations to the sensory changes found after brain injury. In many such cases there will be no apparent sensory defect if the patient is examined with one stimulus at a time in any one area.

If stimuli are applied simultaneously in two of the sentient areas, however, it may be that, in one of them, there is no appreciation of the stimulus. It is as if the stimulus in one area extinguishes the appreciation of a stimulus in the other area. This type of extinction, elicited by double simultaneous stimulation, has been found for visual as well as auditory, gustatory, and cutaneous modalities.

The authors suggested that the apparent absence of vision in a hemianopic region under conditions of daylight is another instance of extinction of a defective area by an homologous area of lower threshold. Such an interpretation makes it understandable that function is present in the defective area under conditions of darkness and a tiny luminous target.

Under these conditions of darkness there are no adequate visual stimuli arising from the background of the visual field, particularly from the normal half, and consequently there is no influence on the stimulus figure which is held in the ordinarily defective or blind half field of vision.

Despite this theory the question of final interpretation of these data must remain open. All that can be said is that a target may be seen and localized in perimetrically blind areas, provided that the examination is carried out in darkness with a small luminous target. Evidently, by modifying the conditions of examination it is possible to disprove the assumption that a perimetrically blind region of a field of vision is necessarily an area of complete loss of function.

Discussion. Dr. Max Chamlin said that one should not stop with the use of a three mm. test object, but should test with other size test objects before an area is considered blind. He also stated that using light against a dark background is in effect changing the character of the stimulus. He stated that, in testing, he increased the size of the test object, and exhausted these possibilities before he changed the character of the stimulus. He also said that it is nice to have the exact relationship between corresponding visual angles.

Present status of gonioscopy

Dr. Saul Sugar (Detroit) said that approximately 50 years have now passed since the introduction of gonioscopy, but it has been only 15 years since it has become at all significant in clinical work. Gonioscopy has many practical applications, which may be subdivided as follows: (1) Its use in studying pathologic changes in the region of the limbus and chamber angle; (2) its application to the study of glaucoma.

In studying disturbances in the limbal region and chamber angle, gonioscopy permits direct observation of congenitally anamolous tissues, neoplastic tumors, cysts, foreign bodies, traumatic changes, and inflammatory changes and their sequellae. It is also valuable in cases of corneal opacity in which some clear cornea remains peripherally to determine the condition of the iris, lens, and chamber angle when keratoplasty or corneal tattooing may be contemplated.

In its application to the study of glaucoma, gonioscopy has led to a better understanding of certain forms of glaucoma, especially acute (narrow-angle) glaucoma, and glaucoma following cataract removal.

It has resulted in a sharper clinical differentiation between the various glaucomas —most important, between acute (narrow-angle) glaucoma and simple glaucoma. The first of these has been shown to be due to mechanical obstruction of the functional portion of the trabecular wall, either by a temporary contact between the iris and trabecular wall or by true peripheral anterior synechias.

In this form of glaucoma there is no evidence of impairment of function of the trabecular wall or Schlemm's canal as is shown by the low tonometric readings obtained after relief of an acute glaucomatous attack. However, this form of glaucoma is always associated with narrowness of the angle as a predisposing factor, apparently the result of the normal increase in the size of the lens in eyes with predisposing relative shallowness of the anterior chamber.

In simple glaucoma the chamber angle is normal in width, varying from wide to narrow as in the normal, but there is probably an impaired function of Schlemm's canal mechanism which cannot be recognized gonioscopically.

Gonioscopy is particularly of value in distinguishing between acute primary glaucoma and acute secondary glaucoma associated with inflammation. The fact that the angle in true acute primary glaucoma is nearly always bilaterally narrow is an important aid in differentiation. The latter distinction is particularly helpful in diagnosing acute glaucoma due to intumescence of the lens, although bilateral cases do occur. Gonioscopy is often the only means of differentiating between the glaucoma occurring after cataract extraction (due to complete synechia formation) and that due to iridocyclitis.

One of the most valuable contributions of gonioscopy is the knowledge obtained from examination of the sites of previous antiglaucoma operations, as well as the sites of contemplated operations. Observations as to the causes of failure of the various operations have contributed considerably to our knowledge of their modes of action.

In this regard, iridectomy aims at freeing the corneoscleral trabeculum over a sufficiently large portion of the angle circumference to permit exit of aqueous. In addition, it destroys the tendency to physiologic iris bombé which occurs in acute primary glaucoma.

Cyclodialysis aims at establishing a communication between the anterior chamber and the suprachoroidal space.

The filtering operations depend on the subconjunctival drainage of intraocular fluid, through an unobstructed scleral channel. Goniotomy aims at freeing the trabecular wall from any obstructing persistent fetal tissue. Whether this is actually the mode of action of the operation is debatable.

Bernard Kronenberg,
Recording Secretary.

OPHTHALMOLOGICAL SOCIETY OF MADRID

March 9, 1951

Ectropion operation

Dr. Marin-Amat presented a woman who was operated on for a complete ectropion of the upper lid, following a malignant pustule, by a dermal-epidermal graft taken from the inner aspect of the arm. The func-

tional and cosmetic results were perfect. The graft has the flexibility, the coloration, and the sensitiveness of the adjacent structures.

Corneal transplantation

Dr. Tena Ibarra presented a woman who underwent a corneal transplantation which in spite of the difficulties of the case (extensive leukoma, many synechias, partial opacification of the crystalline lens) has given excellent results, perfect transparency of the graft, with great improvement in vision.

Retrolental fibroplasia

Dr. Marin-Amat and Dr. Nunoz Plat presented a case of retrolental fibroplasia in a girl, aged eight months, who was born prematurely (seven months) with a birth weight of only 950 gm., and who in general was very feeble. The mother had suffered from a severe gastro-intestinal disorder during the first three months of pregnancy, with continuous vomiting and a loss of weight of six kilos.

When the infant was five months old, the mother noticed the infant's vision was getting worse and two months later, noticed a whitish reflex in the pupils of both eyes. The ocular examination showed microphthalmos of both eyes, especially marked in the left eye. In this eye one could see a grayish-white mass behind the crystalline lens. In the fundus of the right eye was seen a similar mass, in the lower-outer sector, which gave the impression of a detachment of the retina.

As a result of these observations, the authors made a detailed study of this ocular affection, which has so alarmed the American ophthalmologists since in America this is the chief cause of infantile blindness. In Spain, this is the second case which has been published.

Subsequently, the authors described the three clinical varieties: (1) Retrolental fibroplasia which is found primarily in prematurely born babies; (2) persistent hyperplasia of the primitive vitreous which is seen in babies born at full-term and is unilateral; and (3) retinal dysplasia which is found in the newly born and is not related to premature birth. It is always bilateral, and the eyes are usually microphthalmic. Finally, they discussed briefly the etiology and the treatment. There was no discussion.

Bilateral anophthalmos

Dr. Marin-Amat and Dr. Nunoz Plat presented the case of a baby boy, aged five months, with congenital bilateral anophthalmos. He was a full-term baby, with a history of nothing unusual in the family or during the pregnancy of the mother except that her diet during pregnancy, as it was prior to pregnancy, was entirely fat-free.

An examination showed the typical facies associated with the absence of both eyeballs, a very tiny palpebral fissure, and double blepharophimosis. The conjunctival space was very small and rose colored, and it was not possible to make out any deep orbital tissues.

In the orbital cavity of the left eye one could neither see nor feel even a rudiment of an eye. In the right orbit, however, one could palpate a tiny mass.

Joseph I. Pascal,
Translator.

AMERICAN JOURNAL OF OPHTHALMOLOGY

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DA VINCI'S NOTEBOOKS

This year marks the fifth centenary of the birth of Leonardo da Vinci. His private notebooks, when finally deciphered and translated, revealed the most versatile genius of recorded time. Yet, in tragic irony, the impact of his grandeur on the history of science seems nil. All his work had to be rediscovered in succeeding centuries, and his accurate observations and amazing insight in every field of knowledge were apparently without influence.

In his lifetime (1452-1519), Greco-Roman culture and art were in favor, but science was linked by the views then current to subversive materialism. Leonardo was lauded for his ability in painting, sculpture, architecture, music, and engineering. He sought no disciples in science, however, and never published even a fragment of his conclusions.

A brief imprisonment in youth, while awaiting trial on an unfounded charge of homosexuality, impressed him with the fear-

ful power of organized society. This experience was one of many factors that deterred him later from founding an academy and astounding the world with his original and sensational treatises on everything, including visual optics.

The passion for perfection, by which he was inspired, likewise inhibited definitive accomplishment. As a consequence his life's path was strewn with masterpieces left unfinished, with grandiose projects uncompleted, and with his vast knowledge undivulged.

His scientific preoccupation was ridiculed and his suspected emancipation from theological conceptions was misinterpreted. In referring to Leonardo, Castiglione—a contemporary—wrote: "Another one among the foremost painters in the world despises that art, in which he is of the rarest excellence, and has addressed himself to the study of philosophy, in which he has such strange conceits and new fantasies as he could not depict with all his art." And Vasari, in the first edition of his "Lives," stated: "He submitted to no religion, for he considered it a greater enterprise to be a philosopher than a Christian."

In 1515, Francis I of France installed Leonardo at Amboise as court painter. A year later, aged 64 years, Leonardo suffered the first of a series of paralytic strokes from which he finally succumbed. During his convalescence he was visited by Cardinal d'Aragone and his secretary to whom he first revealed his notebooks. In these were recorded his ideas and observations for the previous 40 years, profusely adorned with beautiful sketches. The notes were written in mirror writing in the Italian of that day.

These notebooks had been his sole confidant and contained his diary, notes from reading, random sketches, studies for prospective commissions, inventions and material for contemplated treatises on painting, human and comparative anatomy, geometry, mechanics, hydrodynamics, astronomy, fossils, bird flight, speech, city planning, and optics—all in a confusing jumble.

The notebooks were bequeathed to his devoted last pupil, Francesco Melzi, whose heir, on eventually learning of their existence and value, began the disposal. The originals are now widely scattered—principally in the British Museum, South Kensington Museum, Windsor Castle, Oxford, Institut de France, Ambrosiana Library in Milan, and the Royal Library in Turin.

In recent years, facsimile reproductions have been made of nearly the whole of the known Leonardo notebook material, a complete collection of which is in the United States as the basic feature of the private library of Vinciana assembled by Dr. Elmer Belt of Los Angeles.

The collection consists of about 20 notebooks containing over 7,000 pages. In 1651, a *Treatise on Painting* was printed from Leonardo's writings, but the scientic manuscripts lay unheeded till 1880 when Ravaisson-Mollien of the Institut de France made the first important step toward their elucidation. Since then the work has been continued zealously, chiefly by Jean Paul Richter of Oxford and Edward McCurdy.

As a painter, Leonardo was led to study the laws of optics and the structure of the eye. To learn how an image was formed on the retina, he produced the camera obscura (independently re-invented by Porta in 1588), and, as usual, illustrated his findings with a number of excellent drawings. He was the first to show that the eye as an optical instrument is a contrivance based on the same principle as the camera. From his notebook comes this quotation:

"Experience as to the question how objects send their pictures into the eye reveals itself when the images of illuminated objects enter through a small aperture into a dark building. You will then catch these images on white paper which is set up not far from the opening in the dwelling mentioned, and on this paper will behold all the mentioned objects with their proper forms and colors, but they will be smaller and the uppermost

will be turned downward. . . . In a similar manner does the ray act within the pupil."

He accounted for the experience of a straightforward image by supposing that a second inversion of the rays took place at the crystalline lens.

Leonardo was the first to explain the creation of three-dimensional imagery through the differing perspective produced by the two eyes. He concluded also that the eye requires time to absorb impressions, from his observations of the apparent doubling of a vibrating metal strip, and of the circle of light formed by a rapidly revolving torch. He suggested the phenomenon of irradiation on perceiving that when one end of an iron rod is made red-hot it seems thicker than the other end. He recognized that the twinkling of the stars was an optical illusion which he could eliminate by use of the pinhole. He detected that the hue of an illuminated object is affected by that of the luminous body. As he became older, he reflected on the decreasing strength of vision that accompanied advancing age and had stronger lights hung from the ceiling.

Leonardo appreciated the optical importance of the pinhole and in the following passage anticipated experiments independently described by Scheiner in 1619:

"Let a fine opening be made with the point of a needle in paper, and then let objects on the opposite side of the paper be viewed through the perforation. If, now, the needle is moved between eye and paper straight from above downwards, then the motion of the needle will appear on the opposite side of the opening in a direction contrary to that of its real motion."

In Leonardo's analysis of the acceleration of freely falling bodies, he illustrated his text with a diagram showing horizontally the intervals of time and vertically those of distance, probably the first graph in the history of science. His personal studies foreshadowed the discoveries of Copernicus, Galileo, Harvey, Newton, and Vesalius. Had his work been published, the knowledge of nature would have advanced at one bound at least a century, and he would have justly been acclaimed the first modern man of science. But to award Leonardo priorities for the numerous truths he first envisioned is to lose the true perspective of the march of progress. Yet the fact that such a unique man once lived who could demonstrate equal preëminence in art and science has proved in itself an inspiration to mankind.

James E. Lebensohn.

CORRESPONDENCE

Cylinder rotation test

Editor,

American Journal of Ophthalmology:

There are one or two points in Dr. Fantl's article on "The cylinder rotation test" in the December, 1951, issue of the JOURNAL which call for some comments. Dr. Fantl says "the English literature does not bestow a name on this angle," referring to the angle termed by Lindner, Kramer, and others, "Richtwinkel."

In my book *Modern Retinoscopy* (London, Hatton Press, 1930) and in subsequent articles (for example, "Fundamental principles of cylinder retinoscopy," Am. J. Ophth., **17**:120 (Feb.) 1934; "Cylinder retinoscopy—simplified," Am. J. Ophth., **26**:1304 (Dec.) 1943) I termed this angle, "guide angle," as it is by the size and position of this angle that the examiner guides himself in estimating the correctness of the cylinder axis or the cylinder power. Some earlier English writers had called this angle, "direction angle," a term which conveys nothing of the meaning or significance of this angle.

Lindner in describing the rotation test uses throughout his discussion the term "Richtwinkel" (guide angle) and only in one place does he use the term "Drehwinkel" (rotation angle). I believe the latter is just a slip of the pen as he does not define

anywhere the term "Drehwinkel." The "Richtwinkel," or guide angle in English, when plus cylinders are used, is the angle between the axis of the inserted plus cylinder and the "myopic meridian," that is, the meridian in which there is "against" movement or in which lies the "hyperopic (with-moving) astigmatic band." Similarly, when minus cylinders are used, the guide angle is the angle between the axis of the inserted minus cylinder and the "hyperopic meridian," that is the meridian in which there is a "with" movement or in which lies the "myopic (against-moving) astigmatic band."

By derivation and significance this angle is called "guide angle" because the examiner guides himself by the size and position of this angle as to the correctness of the inserted cylinder both as to power and axis. This is the real meaning and origin of the German term, "Richtwinkel," and is so used by all writers on the subject.

I think it is unwise, and certainly it may lead to confusion, to apply the term "rotation angle" to this angle. Since the publication of my book, various articles in English dealing with cylinder retinoscopy have always referred to this angle as the "guide angle."

The term rotation angle may be applied to what Dr. Fantl calls "angle alpha" and is, as a matter of fact, so called "Drehwinkel" (rotation angle) by Dr. Kramer in his discussion of the cylinder rotation test. It is a suitable name in this particular test as it is the angle through which the cylinder has been rotated in order to check on the correctness of the cylinder strength.

Lindner refers to the angle between the correct axis of the required cylinder and the false axis of the inserted cylinder, in all cases, as the angle of "Fehlstellung," which in my book I rendered into English as the angle of "malplacement or malposition." In fact, Dr. Fantl himself uses the term malposition once for this angle though everywhere else he refers to it as angle alpha. However, in this special case the angle may also be termed "rotation angle" as Kramer has done. But by no means can this latter term be applied to replace the term "guide angle" for the "Richtwinkel."

One other point worth noting is the author's statement, "it is often advantageous to postpone the final estimation of the spherical component of a refractive error until a correct cylinder has been found."

Unless one has a very keen eye and a great deal of experience it is very difficult to note and appraise the phenomena of cylinder retinoscopy before one meridian has been neutralized as accurately as possible with a sphere. Dr. Lindner emphasizes this point and I have always done so in my teaching. In fact, otherwise one may not even get the characteristic phenomenon of oblique opposite movements in the newly created false mixed astigmatism.

In bringing up these points I do not mean to detract from the very excellent presentation of this test which is relatively little known in the English-speaking countries.

(Signed) Joseph I. Pascal,
New York.

BOOK REVIEWS

SURGERY OF THE OBLIQUE MUSCLES OF THE EYE. By Walter H. Fink, M.D. St. Louis, Missouri, C. V. Mosby Company, 1951. 350 pages, 93 illustrations (18 in color), 130 references. Price: $8.75.

The author presents the detailed surgical anatomy of all of the extraocular muscles of the eye, as well as of the obliques from the posterior aspect. He includes the embryology, comparative anatomy, and miscroscopic anatomy. The prodigious amount of work in the dissections and preparations for this volume have been appreciated at the exhibits that have been prepared for the Academy of Ophthalmology and Otolaryngology in the past several years, and it is good to see the

work condensed into book form.

The diagnosis of the oblique muscle defects takes up almost 100 pages in which all the testing procedures are reviewed. One feels, however, that the author has reached no definite procedure which is satisfactory to him; therefore, he does not reassure the student.

The relation of the ocular muscles in the anatomic problems of surgery for separation of the retina is taken up in the appendix. The index of 130 references completes the volume. Beulah Cushman.

TEXTBOOK OF REFRACTION. By Edwin Forbes Tait, M.D., Ph.D. Philadelphia, W. B. Saunders Company, 1951. 418 pages with 93 figures. Price $8.00.

The question might legitimately be raised as to the actual need for an additional text book on refraction when there are already several which seem to serve the field quite satisfactorily. In defense of this new volume, however, it may be said that it is not "just another book on refraction" but is a clinical presentation of the author's views on the subject. These are frequently unorthodox and original and, while few readers will be in complete agreement with all views expressed, there is evidence of intensive study and a profound interest in this field.

The book is almost entirely clinical, a knowledge of physiologic optics and anatomy being presupposed. A rather large section, some 135 pages, is devoted to anomalies of the extraocular muscles. Aside from the chapters on the various errors of refraction and their correction, there is some brief discussion of orthoptics, aniseikonia, and a final "system of refraction" in tabular form.

It is to be noted that the terminology used by the author and many of his concepts show the influence of an early nonmedical background. For example, the keratometer and "dynamic retinoscopy" are given what will seem to many to be an undue emphasis; whereas, the use of cycloplegics is perhaps minimized. The practice of the author in prescribing bifiocals in nonpresbyopic myopes previously uncorrected, while occasionally warranted, will not find universal approval as a routine procedure. His statement that photophobia may be the result of excessive use of the accommodative mechanism is to be doubted. There are a few typographical errors and the practice of describing the cylinder axis as seen by the patient instead of the examiner in his graphic illustrations is confusing.

These critical comments do not invalidate the book as a useful text. It is a worthwhile addition to any ophthalmological library but it should not be the sole text of the student of refraction. William A. Mann.

FROM A DOCTOR'S HEART. By Eugene F. Snyder, M.D. Chicopee Falls, Massachusetts, Philosophical Library, 1951. 240 pages. Price: $3.75.

When I was asked to review Dr. Snyder's book, I did not expect to find that, not only had Dr. Snyder become a member of my club, "The Coronary Club," but, ironically enough, that he was born about a stone's throw from my home town. He unceremoniously left it for the same reason I did; however, I came directly to the United States at a much earlier period. I share with him the meaning of true freedom and also a mutual distaste for dictators of any stripe.

This book about a well-trained general practitioner who acquired a coronary thrombosis, his mental and physical struggle during and after the acute phase of the attack, and his complete recovery is easy to read. It makes sense both to the medical and nonmedical man, and especially to the specialist. His thoughts on the causes of the disease, his philosophy, and the warning he sounds to others are in the finest tradition. This is to be read and enjoyed by everyone.

The subject is lightened by humor in spite

of a scientific approach. It is unique, too, in that it instructs the members of the family of a "coronary" in their duties, particularly when the victim is a physician himself.

The book has a foreword by Dr. Paul White of Boston. Nathan K. Lazar.

Red-Green Blindness as an Experience. By Dr. Heinz Ahlenstiel. Göttingen, "Musterschmidt," Wissenschaftlicher Verlag, 1951. 43 pages, two black and white illustrations, one color circle. Price: Not listed.

This monograph, written by a color-blind physician for those afflicted with color blindness, is also of unusual interest to the ophthalmologist, physiologist, psychologist, and artist.

The presentation is based on Ostwald's concept of four principal hues: Yellow, red, blue, and green, and their intermediate tones, resulting in at least 24 varieties. (Actually, a color-efficient observer is able to differentiate some 120 hues). The color-blind individual appreciates merely yellow, blue, and various shades of gray. Only a narrow band in the red portion of the color circle looks like a true gray to the color blind, and its exact position is the determining factor that renders him a protanope or deuteranope. All the peculiarities and differences of these two seemingly diametrically opposed anomalies can be readily understood on this premise.

After perusing this little volume, it is quite possible for the trichromate reader to envisage the world of the color blind. It should be almost as easy for the color-blind observer to overcome his disadvantage and gain a fairly accurate conception of the world of the trichromate.

An extremely stimulating chapter is devoted to the color-blind painter. A list of colors corresponding to those in the Ostwald color circle is given that should be grouped in a consecutive fashion. While it is not suggested that the color-blind painter would ever be able to create works of art for the great masses, he may open new vistas of art to millions of his co-suffers.

Stefan Van Wien.

Methods in Medicine. By George R. Herrmann, M.D., Ph.D. St. Louis, C. V. Mosby Company, 1950. 479 pages, clothbound, index. Price: $7.50.

This book is divided into five parts, dealing with methods of routine case study, laboratory procedures and tests, methods of clinical investigation, therapeutic methods, and dietetic methods.

As a guide to clinical and laboratory methods employed or recommended to be employed by the internist or general practitioner, it contains little of practical interest to the ophthalmologist. William A. Mann.

ABSTRACT DEPARTMENT

EDITED BY DR. F. HERBERT HAESSLER

Abstracts are classified under the divisions listed below. It must be remembered that any given paper may belong to several divisions of ophthalmology, although here it is mentioned only in one. Not all of the headings will necessarily be found in any one issue of the Journal.

CLASSIFICATION

1. Anatomy, embryology, and comparative ophthalmology
2. General pathology, bacteriology, immunology
3. Vegetative physiology, biochemistry, pharmacology, toxicology
4. Physiologic optics, refraction, color vision
5. Diagnosis and therapy
6. Ocular motility
7. Conjunctiva, cornea, sclera
8. Uvea, sympathetic disease, aqueous
9. Glaucoma and ocular tension
10. Crystalline lens
11. Retina and vitreous
12. Optic nerve and chiasm
13. Neuro-ophthalmology
14. Eyeball, orbit, sinuses
15. Eyelids, lacrimal apparatus
16. Tumors
17. Injuries
18. Systemic disease and parasites
19. Congenital deformities, heredity
20. Hygiene, sociology, education, and history

1

ANATOMY, EMBRYOLOGY, AND COMPARATIVE OPHTHALMOLOGY

Alajmo, A. **The length of the optic axis in the living eye.** Boll. d'ocul. **30**:530-540, Sept., 1951.

Alajmo used the Nordenson-Berg method to measure the posterior corneal curvature and the refraction of six aphakic eyes in order to calculate the length of the optic axis. It varied between 23.14 and 25.52 mm. K. W. Ascher.

Itahashi, Keikyo. **The nerve fibers of the rabbit cornea.** Acta Soc. Ophth. Japan **56**:42-49, Jan., 1952.

The author studied the distribution of vegetative and sensory nerve fibers in the rabbit cornea and claims that they each have their own terminal reticulum in the cornea. Then he studied degeneration of the corneal nerve fibers after death. When the cornea is kept at room temperature, the first sign of degeneration appears six hours after death and complete degeneration occurs after one week. Refrigeration, however, will about double these periods of time. Yukihiko Mitsui.

Loewenstein, Arnold. **Closed branches of conjunctival vessels.** Brit. J. Ophth. **35**:595-600, Oct., 1951.

Normal and dilated conjunctival vessels were studied with the slitlamp. In the normal eye many fine capillaries were found empty, others contained single red blood cells. Some of the larger conjunctival and especially the deep episcleral vessels contained a smaller proportion of red blood corpuscles, and the blood seemed to be diluted with aqueous. The perivascular lymph spaces were present in the middle layers only, and sharply delineated. Fine razor slices were examined without and with staining. Some branches were partly filled with endothelial cells; some had a lumen, some did not. Sphincters were found on twigs but no nuclei of the sphincter muscles could be determined. These have been demonstrated in the blood vessels of the retina and other tissues. Some of the capillaries at the limbus terminated in end-capillaries which may be surrounded by a fine gelatinous tissue or jelly. This jelly may contain red blood corpuscles and may have a fine granular substance or be composed of

single granular cells. Its function is not known. (9 figures) Orwyn H. Ellis.

Sondermann, R. **The biologic significance of the mesenchymal eye pigment.** Ophthalmologica **122**:166-171, Sept., 1951.

The pigment in the mesodermal elements of the eye seems to take its origin from the nuclei of the fetal erythroblasts. The rate of obliteration of purely embryonic vessels and the survival time of erythroblasts in the circulating blood are the factors that determine the intensity of mesodermal pigment formation.

Peter C. Kronfeld.

Thomassen, T. L., and Bakken, K. **Anatomical investigations into the exit canals of aqueous humour. A preliminary study.** Acta ophth. **29**:257-268, 1951.

The aim of this investigation was to reveal the structure of the aqueous veins and their intrascleral course and connections, and to study the juncture of the canaliculi and the intrascleral veins. The study was made on eyes enucleated for melanoma, and the means of identification was India ink, which, after injection into the anterior chamber, flows freely into the episcleral vessels. A section of the sclera containing an aqueous vein was frozen before the enucleation was completed, or such a section was punched out and fixed. The microscopic sections of the four eyes studied show that the aqueous veins originate from Schlemm's canal. In the inner part of the sclera the aqueous vein is a canaliculus; it joins a blood vein in the external portion and its wall is that of a vein. In their course through the sclera these veins have one or more connections with intrascleral blood vessels and do not differ from the epibulbar veins that are directly connected with the canaliculi. It is always a canaliculus from Schlemm's canal that joins a blood vein intrasclerally. An aqueous vein arises at the juncture of a large canaliculus and a small blood vessel at a point where the pressure in the meeting vessels is such that the recipient vein is dominated by the contents from the canaliculus. The two vessels accompany each other in a common scleral canal, separated only by the wall of the vein and the one layer of endothelium before they unite. This anatomical relation confirms Thomassen thesis that the pressure in the two vessels in the scleral canal must determine the quantity of liquid that each of them empties into the recipient vein. If the pressure in the vein is high, it will compress the canaliculus so as to reduce or arrest the escape of aqueous humor. If the pressure in the vein is low, the vein will be compressed and there will be a larger flow of aqueous. The escape of aqueous humor appears to be regulated by the intravenous pressure at the intrascleral juncture of the two vessels, and not at their visible juncture in the episclera. Even if the aqueous vein looks clear, it must be assumed to have already joined a blood vein in the sclera. The anatomical relation of the two vessels also explains the observations made on the aqueous veins in simple glaucoma; it was found that they contain a small quantity of liquid and much blood if the intraocular pressure is in the increasing phase, and much clear fluid and little blood when the ocular tension is falling. These findings indicate that the cause of the obstruction to the escape of aqueous in simple glaucoma is a high venous pressure. (5 figures) Ray K. Daily.

Töndury, G. **The effect of maternal rubeola on the development of the eye of the embryo.** Klin. Monatsbl. f. Augenh. **119**:449-459, 1951.

The eyes of five embryos, the youngest approximately two months, the oldest within two weeks of term, were examined microscopically and the findings evalu-

ated in the light of an accurate maternal history. All the mothers were known to have had an attack of rubeola some time between the 35th and 51st day after the last menstrual period, that is, when the embryos were 21 to 37 days old. The eyes of the embryos examined showed degeneration of the fibers of the lens, thickening of the capsule, and varying degrees of microphthalmos. The disease process is progressive and the central cataract eventually becomes total. Töndury believes that a destructive disturbance of growth and differentiation is caused by the rubeola virus, which has entered the chorion-epithelium. Whereas the adult responds to invasion with granulocystosis, in the embryo the cells of the organ themselves act as phagocytes and are thereby destroyed. The lens is the site of attack because the embryonal lens fibers have a very intense rate of proliferation and an unusually strong growth urge. The lens is at all times without blood vessels and the disease process can therefore continue beyond the stage of acute infection. The cataract is not the result of malformation but of embryonal disease which can occur only in the stage of proliferation and differentiation. After the twelfth week, rubeola in the mother does not bring about the lenticular disease. (8 figures)

B. T. Haessler.

Tyner, G. S. **Ophthalmoscopic findings in normal premature infants.** A.M.A. Arch. Ophth. **45**:627-629, June, 1951.

The fundi of 200 normal premature infants examined showed hazy media, pallor of the peripheral retina, frequent occurrence of large retinal veins, a tapetum-like reflex often seen in darker-skinned infants, and occasional retinal hemorrhages. It is important to differentiate these findings from the more pronounced changes seen in the acute stage of retrolental fibroplasia. John C. Long.

2

GENERAL PATHOLOGY, BACTERIOLOGY, IMMUNOLOGY

Alagna, G. **Lipotropic factors and the visual apparatus.** Arch. di ottal. **54**:195-218, Sept.-Dec., 1950.

Twenty albino rats were fed on a low protein, high fat diet, and 10 others on the same diet with 20 to 30 mg. of methionine. The animals of the first group were killed after 8 to 210 days, those of the second after 8 to 113 days. Ophthalmoscopic and postmortem examinations showed no fundus lesions. Two animals of the first group had bilateral, and one unilateral, stationary, linear, Y-shaped opacities in the anterior cortex. Two rats of the second group had similar bilateral opacities. Four animals of the first and two of the second group had superficial, avascular corneal opacities after 4 to 7 weeks. These findings are not considered as due to a deficiency in lipotropic factors but as a primary hypo-disproteinemia, perhaps associated with other complex, unidentified factors. John J. Stern.

Bocci, G. **Ocular anaphylaxis against bacterial antigens.** Boll. d'ocul. **30**:433-442, July, 1951.

Staphylococcic anatoxin, staphylococcic-streptococcic and pneumococcic antibacterial vaccines were instilled daily for 15 consecutive days into the conjunctival sac of rabbits in order to produce specific allergic sensitization. One month later, the same antigens were injected intravenously. Severe hyperemia and mucous discharge developed in the eye previously treated with the staphylococcus antigen, whereas the streptococcic and pneumococcic vaccines produced no pathologic reaction. (References) K. W. Ascher.

Fornaro, Luigi. **The eye in the general syndrome of adaptation. V. The possibility**

of inhibiting the ocular lesions of overdosage of cortisone with ACTH. Rassegna ital. d'ottal. **20**:128-138, May-June, 1951.

Experiments were performed on rats to determine whether the simultaneous administration of ACTH was able to inhibit or annul the lesions in the ciliary body produced by large doses of cortisone. Thirty-nine rats from which one of the kidneys had been removed were fed a diet rich in proteins and normal salt solution. They were then given large doses of cortisone, followed by equally large doses of ACTH. The combination led to a reduction in the formation of connective tissue and in the destructive effects of cortisone on the ciliary epithelium.

Eugene M. Blake.

Hallett, J. W., Leopold, I. H., and Steinmetz, C. G. **Effect of systemic cortisone and corticotrophin (ACTH) on experimental herpes simplex keratitis.** A.M.A. Arch. Ophth. **46**:268-270, Sept., 1951.

Corticotrophin and cortisone, systemically administered, have an identical retarding effect, up to the fifth day, on experimental herpes-simplex infections of the rabbit cornea. This is in contrast with the lack of benefit, or even deleterious effect, exhibited by local cortisone therapy. R. W. Danielson.

Marsico, Vincenzo. **Experiments on the action of penicillin on hemolytic streptococcus and on staphylococcus pyogenes aureus in vivo, in the conjunctival sac and in vitro in cultures of aqueous humor.** Arch. di ottal. **54**:233-246, Sept.-Dec., 1950.

The study is divided into four parts. In part one, 10 cases of pseudo-membranous conjunctivitis, due to streptococcus hemolyticus, were treated with five intramuscular injections of 200,000 U. (units) penicillin at two-hour intervals with good results. In part two, streptococcus hemolyticus was inoculated in vitreous freshly obtained from rabbits who had previously received eight injections of 10,000 units penicillin per kg. of bodyweight. In the aqueous of five untreated animals, 600 to 1,500 million streptococci were recovered after 48 hours; in the aqueous of five pretreated animals 300 to 600 million were found. The author believes that penicillin injected intramuscularly passes into the aqueous and attains therapeutic levels. In part three, two cases of chronic conjunctivitis due to staphylococcus aureus were cured with 25 three-hourly injections of 200,000 units of penicillin. In part four, staphylococcus aureus was inoculated into the aqueous of untreated and penicillin-treated rabbits. In four untreated animals 1,700 to 3,000 million organisms were found with the Welkome opacimeter and in the four pretreated animals there were an estimated 1,300 to 2,600 millions. Intramuscular injections of penicillin seem to reach the aqueous in appreciable amounts. John J. Stern.

Muscas, M. **The presence of nuclei in the Morax-Axenfeld diplobacillus.** Boll. d'ocul. **30**:505-512, Aug., 1951.

Morax-Axenfeld diplobacilli were obtained in smears from 10 patients with angular conjunctivitis. Bacilli were taken from the cultures of one of these patients and, using Robinson's and Tulasne-Vendrely's methods, two elongated basophile nuclei were found at the ends of each organism. Morax-Axenfeld diplobacillus grows slowly; the change from cytoplasmic augmentation into nuclear division takes six to seven hours whereas in other bacteria only three to four hours are required. K. W. Ascher.

3

VEGETATIVE PHYSIOLOGY, BIOCHEMISTRY, PHARMACOLOGY, TOXICOLOGY

De Berardinis, E., and Auricchio, G. **The hydrolysis of adenosine triphosphoric acid in the retina and its biologic signifi-**

cance. Ann. di ottal. e clin. ocul. **77**:430-453, Nov., 1951.

The authors found that the retina has an enzyme (or enzyme system) capable of liberating two phosphoric radicals from adenosine triphosphoric acid. This enzyme is less active than a similar enzyme in the heart muscle or the liver, but it is the most active of all hydrolases yet found in the retina that can liberate inorganic phosphorus from phosphorated compounds. The hydrolysis of adenosine triphosphoric acid and of adenosine diphosphoric acid in the retina is probably mediated by one and the same enzymatic catalyst. Dark or light adaptation of the retina in vivo has no appreciable effect on the enzymatic activity in vitro, and exposure to light to the point of complete decolorization of a test solution containing rhodopsin likewise has no effect on the activity of the enzyme. It is impossible to prove that the enzyme plays any part in the photochemistry of vision. The enzyme was found chiefly in the pigment epithelium and in the nuclear layers: similar localization has been found for various other phosphatases. (References)

Harry K. Messenger.

Capolongo, Giuseppe. **A possible inhibitory action of the aqueous humor on hyaluronidase.** Arch. di ottal. **54**:259-263, Sept.-Dec., 1950.

Capolongo found that the aqueous humor does not have an inhibitory effect on hyaluronidase.

John J. Stern.

Capolongo, Giuseppe. **Experiments on the action of hyaluronidase injected subconjunctivally.** Arch. di ottal. **54**:219-232, Sept.-Dec., 1950.

After the subconjunctival injection of sodium fluorescein and 20 units of hyaluronidase, the fluorescein appeared in the anterior chamber of the rabbit earlier and in a higher concentration than in a control eye which had not received hyaluronidase. The measurements were made with a Roenne colloidometer. (References)

John J. Stern.

Hallermann, W., Basch, A., and Ladeburg, H. **The action of ultra-sound-waves upon animals' eyes.** Klin. Monatsbl. f. Augenh. **119**:401-411, 1951.

The authors describe their studies in rabbits in which they used an ultra-sound apparatus with a frequency of 1,000 kilohertz and treated the eyes with ultrasound waves for several minutes. They found an increased permeability of the bloodvessels in the exposed eye and a reflex involvement of the second eye. Application of the ultra-sound waves to the cervical sympathetic gave similar results. Increase in ocular tension sometimes occurred.

Ernst Schmerl.

Horne, N. W., and Macaskill, J. **Effect of para-aminosalicylic acid (PAS) alone and in association with streptomycin on experimental ocular tuberculosis.** Brit. J. Ophth. **35**:459-466, Aug., 1951.

The authors determined the concentration of para-aminosalicylic acid (PAS) after subconjunctival and intramuscular administration. In the subconjunctival method, high aqueous levels were obtained, and therapeutic level lasted for three hours. With intramuscular injection, considerably lower levels were found, and shorter therapeutic levels were obtained. In another carefully controlled experiment, the results of treatment of experimentally produced ocular tuberculosis with streptomycin, PAS, and combined PAS and streptomycin were tabulated and compared. All treated groups did better than the control, but those treated with PAS alone did only slightly better, whereas the groups which received streptomycin did significantly better. During treatment the combined group did better, but after the cessation of treatment the group which received streptomycin alone

showed greater improvement. Microscopic examination confirmed the gross findings. In the control and PAS treated groups, dissemination was limited to the lungs, and was more severe in the latter group.

Orwyn H. Ellis.

Langham, Maurice. **Factors affecting the penetration of antibiotics into the aqueous humour.** Brit. J. Ophth. **35**:614-620, Oct., 1951.

The degree of binding of some antibiotics on the nondiffusible constituent of the plasma was determined. Substances adsorbed on proteins will not pass the blood-aqueous barrier, and only the unbound fraction of the antibiotic is free to pass into the aqueous. After determining the rates of entry, degree of adsorption on the plasma proteins and the value of the ether-phosphate partition of the various antibiotics, it was concluded that the rate of entry of the antibiotics tested may be related to their lipoid solubility and that concentration is dependent both on the rate of entry and on the adsorption on the proteins of the plasma. Of the antibiotics in common use, chloromycetin passes the most readily into the intraocular fluids and produces a high concentration within the eye. Orwyn H. Ellis.

Leopold, I. H. **Pharmacology and toxicology. Annual Review.** A.M.A. Arch. Ophth. **46**:159-224, Aug., 1951.

This is a detailed review of the current developments in pharmacology and toxicology of the eye. Special attention is devoted to antibiotics and chemotherapy and to the use of cortisone and corticotrophin. Among the numerous other subjects covered are rutin, streptokinase and streptodornase, hyaluronidase, antihistaminics, fever therapy, irradiation and radioactive materials. John C. Long.

Malatesta, C. **Histopathalogic changes in experimental avitaminosis E of the rat and in other dietary deficiencies.** Boll. d'ocul. **30**:541-552, Sept., 1951.

Vitamin E deficiency causes severe degenerative changes in the retina and lens of rats. The rats were fed 50 grams casein, freed of water-soluble lipids, 500 grams glucose, 400 grams lard, 100 grams sugar, and 50 grams Osborne-Mendel salt mixture fortified with vitamin B-1, pyridoxin, nicotinic acid, calcium pantothenate, paraamino-benzoic acid, folic acid, inositole, vitamin K, and cod-liver oil. Addition of choline to the basically deficient diet did not prevent the development of changes in the retina and lens, but the addition of vitamin E, with or without choline, prevented the pathologic changes. There was loss of differentiation of the retinal layers, with increase of the external nuclei, disorganization of the interneuronic connections and destruction of the pigmented epithelium, and in the lens, the peripheral fibers became interspersed with vacuoles containing protein. (6 figures)

K. W. Ascher.

Morpurgo, Fabio. **Hyaluronidase and hemato-ophthalmic permeability.** Ann. di ottal. e clin. ocul. **77**:425-429, Nov., 1951.

Morpurgo found that hyaluronidase administered subconjunctivally or retrobulbarly to adult rabbits does not alter the permeability of the blood-aqueous barrier as determined by Amsler's method of studying the passage of fluorescein from the blood stream into the anterior chamber. Hyaluronidase may therefore be used in conjunction with local anesthetics, as has been proposed by various investigators, without danger. Administered intravenously, it increases permeability by depolymerizing the pericapillary hyaluronic acid. Previous injections of fargan (a synthetic antihistaminic) or rutin offset the action of intravenous hyaluronidase on the blood-aqueous barrier. (References)

Harry K. Messenger.

Okumura, Makoto. **Metabolism of stored human cornea.** Acta Soc. Ophth. Japan **56**:27-29, Jan., 1952.

The metabolism of human cornea was studied by means of Warburg's method. Human corneas kept in Ringer's solution at 2°C to 4°C maintained a normal carbohydrate breakdown and normal aerobic glycolysis for 18 hours. After the 24 hours, however, a rapid decrease of metabolism was observed and, in five of 10 corneas stored more than 24 hours, the oxygen uptake was zero. Yukihiko Mitsui.

Palm, Erik. **The passage of radioactive sodium from the blood to the ciliary body and the aqueous humor.** Acta opth. **29**:269-290, 1951.

In a former investigation Palm found that the main barrier to the passage of phosphate is situated between the capillary blood and the mass of the ciliary body. Sodium, unlike phosphate, takes no part in the intracellular metabolism, and therefore might be used for a more precise localization. The animals were injected with labeled sodium, and its passage into the aqueous was followed by checking its concentration in the blood, anterior uvea, aqueous, and brain tissue of test animals killed at different periods after the injection. Estimations were made of the total sodium within the samples and the content calculated per unit volume of fluid or dry weight, and of the labeled sodium in terms of counts. The results were plotted as time curves. These showed that the sodium in the anterior chamber is renewed at a rate of about one percent per minute. The aqueous humor curve shows the relative slowness with which sodium penetrates into the anterior chamber. The curves for the blood serum, the uvea and the aqueous in the anterior chamber show that the concentration gradient lies between the blood and the main body of the uvea. There is no significant difference in the content of labelled sodium between the uvea and the aqueous in the anterior chamber. The passage of sodium ions from the anterior into the posterior chamber is very rapid. The experiments indicate that the barrier to the penetration of sodium into the aqueous lies between the capillary blood and the tissue fluid of the anterior uvea, which is the capillary wall. In this respect the eye resembles the central nervous system. (5 figures, 1 table)

Ray K. Daily.

Tagawa, Sadatsugu. **The influence of low temperature on ocular tissues.** Acta Soc. Ophth. Japan **56**:14-26, Jan., 1952.

Temperatures of −10°C, −30°C and −50°C respectively, were applied for 10 minutes to normal rabbit eyes and the changes caused by these temperatures were followed by means of slitlamp examinations and biopsy. In the cornea, the application of low temperature resulted in an edematous degenerative change of the corneal tissues accompanied by an infiltration with leucocytes. In the other ocular tissues there was marked congestion and stasis of the circulation, leucocytic thrombosis and hemorrhage.

Yukihiko Mitsui.

Werner, Ivar. **Cheyne-Stokes respiration associated with rhythmic pupillary changes; a case report.** Acta psychiat. et neurol. **26**:213-217, 1951.

Rhythmic changes in pupillary motility were noted in a 74-year-old woman, for five days before she died of uremia, cardiac hypertrophy, nephrosclerosis and cerebral arteriosclerosis. She had been given a few small doses of morphine and barbiturates and during this time she had been unconscious. The pupils were contracted during apnoea; when respiration began the pupils dilated rapidly, became widest in mid-respiration, then decreased in size as the rate of breathing diminished. Pupillary contraction always occurred during apnoea. The mydriasis was

thought to be the result of anoxemia and the miosis due to a lowered state of consciousness. (26 references)

F. M. Crage.

Wirth, A. **Note concerning the mechanism of the interretinal reflexes.** Boll. d'ocul. **30**:499-504, Aug., 1951.

The author has studied the effect of stimulation of one eye on the activity of the other by means of electroretinography. The electrical manifestation of the consensual activity cannot be recorded, but it is possible to find out its effects by recording the electroretinogram in binocular synchronous stimulation. A "b-potential" is thus established which is lower after monocular stimulation. This finding might be attributed to the integrative action of centrifugal bipolar cells in the retina.

K. W. Ascher.

Zetterström, Birgitta. **The clinical electroretinogram in children during the first year of life.** Acta ophth. **29**:295-304, 1951.

Thirty-five infants with normal eyes were followed from birth to the age of one year. The electroretinogram of the infant is of a different type from that of the adult, and is characterized by the absence of P 3, the negative component. During the first two or three days there is no electroretinogram or only a slight rise in the base line. After a few days an incipient electroretinogram is obtained with a period of latency of 0.06 second from the light stimulus which in the adult is 0.04 second, and the duration of the b-potential, which in adults is 0.15 second prolonged to 0.20 second. There is no a-wave, and the rising part of the b-potential is more sloping than it is in the adult. At about three months a measurable b-potential of 0.10 to 0.20 mV has developed. The period of latency and the duration are shortened to 0.05 and 0.16 second respectively. There is still no a-wave. During the first half year there is a distinct increase in the b-potential. At the end of the first year a trace of a-wave could be observed, and at one year the electroretinogram is of the adult type. (7 figures)

Ray K. Daily.

4

PHYSIOLOGIC OPTICS, REFRACTION, COLOR VISION

Campbell, D. A., Harrison, R., and Vertigen, J. **Binocular vision in light adaptation and dark adaptation in normal subjects and coal-miners.** Brit. J. Ophth. **35**:484-495, Aug., 1951.

Coal-miners, after years of work underground, have better binocular vision than others and the failure which occurs in coal-miners' nystagmus appears to be the result, and not the cause of the oscillations. Stereoscopic vision is the last binocular function to be affected. Since there is a failure of adduction early in the disease, orthoptic training is of great value and should form a part of rehabilitation. The introduction of modern lighting should materially improve the illumination and working conditions. (15 figures)

Orwyn H. Ellis.

de Conciliis, Nicola. **Variations of static refraction during adolescence.** Arch. di ottal. **54**:189-194, Sept.-Dec., 1950.

Two cases in which there were marked changes in refraction over a period of 10 and 16 years are described. One patient had a hypermetropia of 3D when eight years old, which changed into a myopia of 2D. A second patient, with an astigmatism of +2.50 at 90° at the age of 14 years, became very myopic at the age of 32. No abnormalities of growth or development were observed in either patient.

John J. Stern.

Cucco, Giovanni. **Comparative analysis of the various forms of dyschromatopsia and the possible ways of classifying them**

at present. Ann di ottal. e clin. ocul. 77:465-492, Dec., 1951.

In this study, which was awarded the Pardo Prize for 1948-50, Cucco examined 35 typical cases of congenital dyschromatopsia by means of Ishihara's charts and other conventional tests, and also by a new method devised by Professor Luigi Maggiore whereby the anomalies can be determined quantitatively as well as qualitatively and can be recorded graphically. He found that none of the current classifications of color blindness are clinically sound. Certain deviations from the normal are atypical and cannot be classified according to any scheme. None of the theories hitherto proposed has taken due note of the three primary factors, physical, sensory, and psychologic, upon which color vision depends. In view of scanty knowledge, observations should not be forced into this or that theory. The Stilling and Ishihara charts are unreliable and of value only for rough screening, since defects in color sense are by no means parallel to the difficulties encountered in deciphering the various charts. (References)

Harry K. Messenger.

Eckel, K. **The correlation between practical night vision and various dark adaptation tests.** Ophthalmologica 122:154-165, Sept., 1951.

The usual methods of dark adaptation measure only partial functions of the very complex night vision apparatus. The specific purpose of this study was to determine which of these partial functions correlates best with practical night vision. The partial functions tested were: 1. the absolute light threshold as a function of time (routine adaptometry), 2. the visual acuity in dim light and 3. the differential light threshold of the dark-adapted eye. The effect of familiarity with the test conditions and of systematic night vision exercises were also studied. The rate of increase in light sensitivity between the fifth and the fifteenth minute of dark adaptation proved to be most closely related to the overall quality of night vision.

Peter C. Kronfeld.

Fleischer, E. **The physiologic basis of depth perception.** Ophthalmologica 122: 91-105, Aug., and 172-186, Sept., 1951.

After detailed description and psychological analysis of various phenomena of depth perception, the author arrives at the conclusion that the recognition of depth has a twofold basis: 1. the recognition of known, familiar objects ("gegenstandsgemaesse Phaenomene") and 2. the utilization of horizontal disparity, aside from the meaning or significance of the objects. Ordinarily the two mechanisms supplement each other. In exceptional situations, (pseudoscopy, unorthodox paintings or drawings) the two mechanisms may become antagonists, in which case horizontal disparity invariably loses.

Peter C. Kronfeld.

Handousa, Ahmad Bey. **Proptosis caused by hydatid disease.** Brit. J. Ophth. 35:607-613, Oct., 1951.

The orbit is one of the rarest sites of involvement of hydatid disease; the incidence for face, orbit and mouth together is between 0.8 and 2.3 percent in endemic areas. The cyst walls are formed by the germinal layer surrounded by a dense fibrous layer. In circumscribed areas the germinal layer sends out processes into the surrounding tissues which produce metastasis along the lymphatics and blood vessels. In a confined bony area the cyst grows, permeates available bony spaces and destroys the bone. This is termed the osseous cyst. Esophinophilia, the complement-fixation, and intradermal tests are not constantly positive. Nine to 12 years is the most common age for orbital involvement and exploration the most reliable method of diagnosis. X-ray studies after lipoidol filling may be of diagnostic value.

In the three cases reported, prompt recovery followed surgical removal. Enophthalmos may be avoided by leaving a portion of the outer cyst wall.

Orwyn H. Ellis.

Marsico, Vincenzo. **Disturbances of form perception during narcoanalysis.** Arch. di ottal. **54**:247-258, Sept.-Dec., 1950.

A barbiturate (Narcovene) was administered intravenously to 19 patients and during the state of "subnarcosis", before or after complete anesthesia, three tests for optical illusions were given. During this state of semiconsciousness spontaneous nystagmus was always present. The author accepts the opinion of Buscaino that perception of form does not depend on retinal perception alone but also on the activity of the extrinsic musculature, and believes that the results of his experiments add proof to this theory by showing a parallelism between the degree of nystagmus and the degree of disturbance of form perception. John J. Stern.

Richter, Manfred. **New developments in testing color sense.** Klin. Monatsbl. f. Augenh. **119**:561-575, 1951.

Of all color charts, the pseudo-isochromatic are still the ones most often used, and that of Stilling is perhaps the best. In Germany the Ishihara charts have been in common use, but several editions were found inaccurate. A procedure worked out by Trendelenburg and elaborated by Ahlenstiel, in which the subject is required to arrange many small colored discs in a definite pattern, has arroused much interest in Germany, but, as it is not yet commercially available, subjects tested have been few. In his detailed discussion of charts, Richter analyzes the advantages and defects of the various editions of the Ishihara charts and mentions the charts of the Russian, Rabkin, considered superior to Ishihara's by Hardy, Rand and Rittler, the Swedish Boström-Kugelberg charts (not to be confused with the old Boström chart) and those of Meyrowitz, none of which are as satisfactory as the Ishihara or as the charts compiled by the American Optical Company. The 100-shade color test of Farnsworth is favorably mentioned. Richter discusses the anomaloscope of Nagel in considerable detail and believes that all chart tests should be supplemented by an examination with the anomaloscope. He points out that the instrument has apparently found but little favor with American investigators. (7 figures, 29 references) B. T. Haessler.

Shikano, Shin-ichi. **A study of the yellow-field.** Acta Soc. Ophth. Japan **56**:60-63, Jan., 1952.

The visual field for yellow was measured with two shades of yellow. The first was a simple yellow and the second was obtained by mixing lithium red and thallium green light; both had the same brightness and color tone and were obtained by using an anomaloscope. The visual field for "simple yellow" was considerably greater than that for "mixed yellow"; the first corresponded to or was slightly larger than the field for red, the latter corresponded to that for green. The author concludes that, although both yellows can be seen as the same by central vision, they are recognized as different from each other by peripheral vision and this fact suggests the presence of a receptor for yellow in the retina.

Yukihiko Mitsui.

Wüstenberg, W. **Does Adaptinol actually influence dark adaptation?** Klin. Monatsbl. f. Augenh. **119**:524-528, 1951.

Adaptinol (Bayer) is a one-percent solution of helenien (luteindipalmitinic-acid-ester) in oil of arachine. Under accurately controlled conditions, Wüstenberg could find no measurable increase in dark adaptation after Adaptinol, even

when the large doses with which Cüppers and Wagner claim to have obtained such excellent results were given. Two tables explain the experiments in detail.

B. T. Haessler.

5

DIAGNOSIS AND THERAPY

Bottino, Carlo. **A useful apparatus for detecting feigned amblyopia.** Ann. di ottal. e clin. ocul. **77**:418-424, Oct., 1951.

The apparatus described was devised by Professor Luigi Maggiore and has been used successfully for many years at the Genoa Eye Clinic for the detection of simulated unilateral amblyopia. It consists of a dark chamber with two Snellen test charts side by side at a distance of five meters from the patient's eyes and is so contrived with movable screens invisible to the patient, that both charts at the same time, or either chart separately, may be seen with either one or both of the patient's eyes. As the eyes can be kept under constant observation, and the variations in the position of the screens can be executed quickly, silently and invisibly, the patient ordinarily has no means of knowing with which eye he is seeing, unless one eye is really amblyopic. The Snellen charts have the additional advantage of enabling the examiner to determine the degree of amblyopia if it is present. (References)

Harry K. Messenger.

Capalbi, S. **The tolerance of the aqueous and vitreous of rabbits' eyes to terramycetin.** Rassegna ital. d'ottal. **20**:218-229, July-Aug., 1951.

The author introduced 0.5 and 2-percent solutions of terramycetin hydrochloride into the anterior chambers of rabbits' eyes. Solutions up to 1 percent were well tolerated. In another series of rabbits solutions of the same strength were injected directly into the vitreous chamber. There was marked reaction in the framework of the vitreous and the reactive phenomena were in proportion to the strength of the antibiotic. Similar solutions induced retinal changes which consisted of fibrinous formation in the internal layers, and in a decrease of the bipolar cells. (10 figures)

Eugene M. Blake.

Cruthirds, A. E. **Sulfhydryl in tissue respiration and repair as applied to burns in ophthalmology.** J. Intern. Coll. Surg. **16**:356-364, Sept., 1951.

Sulfhydryl prevents infection and stimulates prompt healing in chemical and thermal burns of the eye. Prompt use is important, as the danger period is reached within the first 24 to 48 hours. Roentgen burns have healed with this medication when all else failed. Kuhn reports a chemical burn of the right eye by a caustic from drum fluid machines, which had caused denudation of areas of the cornea and recovery was complete in 24 hours after the accident without impairment of vision. A severe burn of the conjunctiva and lower half of the cornea was followed by vision of 20/40 although treatment was not begun until 18 days after injury. Since 8,000 patients lose one or both eyes from chemical or thermal burns in a year and over 100,000 patients have serious eye burns through accidents, the value of this method of medication bears further investigation.

Claude L. LaRue.

Diener, Fritz. **The treatment of ocular tuberculosis with large doses of vitamin D_2.** Klin. Monatsbl. f. Augenh. **119**:528-533, 1951.

Vitamin D_2 has been used successfully in skin tuberculosis for some time with results that have been superior to ultraviolet radiation. Only A. Vogt has used radiation in the treatment of ocular tuberculosis, although others have advised a sunny, mountainous climate. Diener treated 23 patients with Vigantol forte (10 mg. vitamin D_2). An ampule containing 1cc. was given perorally every other

day, up to 24 ampules; then one ampule twice a week and, after healing was complete, once a week for several months. There were 6 cases of iritis, (4 healed, 2 improved) 7 periphlebitis, (5 healed, 2 unchanged) 4 choroiditis, (3 healed, one unchanged) 3 retinitis, (2 healed without recurrence, 1 with) 1 periphlebitis, iridocyclitis and neuritis remained unchanged, 1 solitary tubercle of the arterial sheath, healed and one conjunctival tuberculosis, healed. Treatment lasted for five months and an average of 30 to 50 cc. Vigantol forte was given each patient. The final results cannot be evaluated until more time will have elapsed. (26 references)

B. T. Haessler.

Doggart, J. H. **Significance of dental sepsis to the ophthalmologist.** Ann. Roy. Coll. Surg. 9:333-338, Nov., 1951.

Doggart believes that there is no special sign, nor any linkage of associated signs, to justify an ophthalmologist in saying that a given case of iridocyclitis can confidently be said to be due to septic teeth. The role of the teeth as a focus of infection in ocular inflammations is no longer considered as important as it was in the past.

Irwin E. Gaynon.

Dorello, Ugo. **The local action on the eye of tetraethylammonium phosphate.** Rassegna ital. d'ottal. 20:201-217, July-Aug., 1951.

The author studied the action of tetraethylammonium phosphate injected subconjunctivally on the ocular tension and the pupillary reaction of rabbits. Doses of 0.15 mg. decreased the intra-ocular pressure, 0.30 mg. produced no change, and over 0.50 mg. increased the pressure. These doses all induced mydriasis. When the injection was combined with the instillation of atropine, hypertension and mydriasis resulted, with pilocarpine and eserine, hypertonus and miosis were noted. Blocking of the post-ganglionic parasympathetic fibers and of the ganglion synpases made the receptors sensitive to acethylcholine inactive. (8 tables, 20 references)

Eugene M. Blake.

Dunnington, J., and Regan, E. **The effect of sutures and of thrombin upon ocular wound healing.** Jackson Memorial Lecture. Tr. Am. Acad. Ophth. pp. 761-773, Nov.-Dec., 1951.

During the first three days the lips of a limbal wound are held together by a fibrin mesh-work. The first step of permanent healing is an epithelial plug which is followed in three to five days by mesoblastic proliferations and scar tissue. The healing process is more rapid if the wound is covered by conjunctiva. Overlapping and gapping of the wound margins retard healing and favor complications. All sutures are potentially foreign substances and cause some tissue reaction. If they are placed too deep or are irritating, stromal necrosis of various intensity occurs and is frequently followed by epithelial ingrowth, fistulization, invasion of the anterior chamber and iris incarceration and prolapse. Hemorrhage into the anterior chamber occurs when newly formed superficial capillaries invade the lips of the wound and is more frequent if their apposition is imperfect. The use of thrombin to seal cataract incisions more rapidly is not advised because it separates the wound edges and reduces the tensile strength of the wound closure. Silk sutures are less irritating than catgut. Plain catgut causes a more rapid tissue reaction than chromic catgut. The latter causes a slower but gradually increasing reaction. The author feels that silk is preferable but further investigation with catgut may prove it to be the material of choice. Sutures should never be inserted to a depth greater than half of the depth of the incision and should not remain longer than 12 days. (9 figures, 32 references)

Chas. A. Bahn.

Dunphy, Edwin B. **Common ophthalmologic problems of childhood.** Postgrad. Med. 10:515-517, Dec., 1951.

A vision of 20/40 is quite satisfactory for children under the age of seven years because the macula of the retina is not fully developed until then. Unless there is strabismus or irritation of the eyes there is no need to refract a child until he goes to school. A true alternating squint will not develop into amblyopia but a monocular squint will and it is necessary to treat the latter by occlusion for at least thirty days. If the child is too young to wear the patch, a cycloplegic is instilled daily. A complete examination should be done on every child that squints by the time he is one year old. The treatment for acute conjunctivitis, tear sac infections, keratitis, lacerations, and vernal conjunctivitis is described briefly. H. C. Weinberg.

Friede, R. **The Schroth treatment in chronic eye disease.** Klin. Monatsbl. f. Augenh. 119:596-607, 1951.

The Schroth treatment is in use in a number of German and Austrian spas and Friede believes that it could be well applied in diseases of the eye, especially in chronic infections. It consists of a low protein diet, the withdrawal of fluid and the use of warm packs. Schroth originally prescribed only dry rolls and withheld all liquids for six days. This has been modified so that "thirst days" alternate with days on which small, and days on which large amounts of warm wine and certain kinds of mush are permitted. The packs are applied at night and are put on cold to the thoroughly warmed body, which may include the head and neck. They are left in place three to eight hours. The treatment continues for three to seven weeks and may be repeated after a suitable interval if desired. The diet is very gradually returned to normal and remains entirely vegetarian for some time.

During treatment there are striking bodily reactions. At first loss of weight is marked, the muscles became flabby, appetite is poor, the urine dark, with large crystals of phosphorus and oxalic acid, there may be diarrhoea or constipation, the heart is slowed and the blood pressure falls. The patient is irritable and depressed. These early, unpleasant symptoms are later replaced by a feeling of wellbeing, of rejuvenation, with renewed hunger, gain in weight and an increase in the red cells and hemoglobin.

For use in private practice, where the patient lives at home, this treatment must be somewhat modified, but the essential features can easily be retained. Friede has found it of benefit in cases of lid eczema, hordeolum, herpes zoster, chronic conjunctivitis, chronic scleritis due to rheumatism or tuberculosis, iridocyclitis, retinitis and choroiditis, vitreous opacities, diseases of the bloodvessels, migraine and toxic amblyopia. In acute eye disease the period of disability is shortened and in chronic disease, when all medication has failed, marked improvement has taken place after this cure. B. T. Haessler.

Klar, R. **The use of antihistamine-like substances in ophthalmology.** Klin. Monatsbl. f. Augenh. 119:494-499, 1951.

Klar has used antihistamine systemically with excellent results in eczema and edema of the lids which had previously resisted all treatment. (References)

B. T. Haessler.

Lyons, Champ. **Isotopes in medicine.** Tr. Am. Acad. Ophth. pp. 782-785, Nov.-Dec., 1951.

The generally accepted concepts of isotopes and their use are briefly discussed. In the more accurate diagnosis of thyroid disturbances and some leukemias isotopes are of value. The elements most frequently used are phosphorus, iodine and gold. This contribution is probably of greater

theoretical interest than practical value to the average ophthalmologist.

Chas. A. Bahn.

Melodia, Corrado. **Sodium propionate in the treatment of extenal ocular disease.** Ann. di ottal. e clin. ocul. 77:359-365, Sept., 1951.

Melodia's experiences with a 5-percent solution of sodium propionate instilled in the conjunctival sac every four hours confirm the favorable results reported by American ophthalmologists. It is particularly effective in acute catarrhal conjunctivitis, catarrhal ulcers of the cornea, and chronic blepharoconjunctivitis. In gonococcal and chronic conjunctivitis, it can replace penicillin when the latter causes irritation. Not one of 93 patients showed any intolerance or allergy to the drug.

Harry K. Messenger.

Musini, A. **The use of the gelatine sponge in ophthalmology (experimental note).** Boll. d'ocul. 30:585-595, Oct., 1951.

In the eyes of rabbits, gelatine foam implants were made under the conjunctiva into the anterior chamber and into the scleral capsule after eviscerating its contents. They were observed over varying periods and were then examined histologically. The gelatine produced slight hyperemia and the pieces, removed 5, 10 and 15 days after implantation, showed gradual resorption. In the chamber, the implant produced no irritation or adhesions; the rabbit could open its eye and the specimens stained with hematoxylin and eosin showed no tissue reaction whatsoever. In the scleral capsule, the sponge was well tolerated over periods of 2 to 30 days, and, pathologically, no tissue reaction was found. Musini believes it is permissible to use gelatine foam in human eye surgery as well. (7 figures, 35 references)

K. W. Ascher.

Nachod, G. R. **ACTH and cortisone in ocular diseases.** J. Am. M. Women's A. 6:453-455, Dec., 1951.

Cortisone and ACTH have been used successfully in the treatment of allergic conditions of the lids and external eye, and in inflammations of the cornea, sclera and uveal tracts. Variable reactions have been reported in secondary glaucoma, optic neuritis, interstitial keratitis, retrolental fibroplasia, and early clouding of corneal grafts. No clear cut therapeutic effect has been noted in Coats' disease, Eale's disease, diabetic retinopathy, malignant exophthalmos, or primary glaucoma. Degenerative lesions have not been benefited. Topical administration is preferred in affections of the anterior segment; for deeper lesions cortisone or ACTH should be administered systemically.

Irwin E. Gaynon.

Rossello, Gioach-no. **Avertin in ophthalmology.** Rassegna ital. d'ottal. 20:233-238, July-Aug., 1951.

The author considers avertin the anesthetic of choice in ophthalmology especially for children. The technique of administration, its action and the effect upon the blood, circulation, liver and kidneys is described.

Eugene M. Blake.

Štěpanik, Josef. **The importance of the starshaped multiple slit in slitlamp microscopy.** Klin. Monatsbl. f. Augenh. 119: 576-580, 1951.

This modification of the slitlamp has the advantage that irregular surfaces can be viewed plastically. The lightbeam emerges in three intersecting planes and brings into view a starshaped section of any membrane in the eye, from the cornea to the fundus. Its only disadvantage is the greater intensity of light, disturbing in the examination of the vitreous membrane and posterior lens capsule, but this can be controlled by obliterating the accessory beams. The method is particularly

valuable clinically when irregularities of surfaces of the vitreous, cornea, and lens are in question. B. T. Haessler.

Thiel, Hans-Lothar. **Priscol in ophthalmology.** Klin. Monatsbl. f. Augenh. **119**:516-524, 1951.

Priscol was frequently used locally, in 10-percent solution, in conjunctivitis and mild keratitis; it was given once in a case of amblyopia after quinine poisoning with strikingly good results, and was used in a number of diseases by retrobulbar injection. In embolism of the central artery there was a complete cure in one of five cases, and no result in the other four. A patient who had been totally blind for four weeks from postneuritic atrophy following grippe, recovered sufficient sight to see fingers after retrobulbar injections of Priscol. Seventeen patients with retinitis pigmentosa were treated: there was definite improvement in one, partial in seven, slight in three and no improvement whatsoever in six. All but one of the patients tolerated the retrobulbar injections well. Priscol is not a cure for retinitis pigmentosa; it is probable that the benefits secured are only temporary. (4 figures, 11 references) B. T. Haessler.

Zarrabi, Massoud. **The use of priscol in ophthalmology.** Ophthalmologica **122**:76-80, Aug., 1951.

Considerable improvement in a variety of conditions (chiefly retrobulbar neuritis) was obtained by means of retrobulbar injections of priscol (daily or every other day) which the author describes as painless, and highly effective.

Peter C. Kronfeld.

6

OCULAR MOTILITY

Hugonnier, R. **The current practical treatment of the amblyopia of strabismus.** Ann. d'ocul. **184**:1030-1037, Nov., 1951.

The author classifies strabismus with amblyopia as primary amblyopia with secondary strabismus and primary strabismus with secondary amblyopia. The former, or structural, group is usually caused by inflammatory or constitutional diseases which involve the media or perceptive mechanism, and occurs especially in the young. With the structural decrease of vision the urge for binocular single vision becomes less and only one eye fixes. Obviously, re-education is of little or no value. In the second, or functional, group, amblyopia is usually caused by a constitutional optical or fixation abnormality (phora-tropia) and one eye gradually deviates. Re-education is frequently justified especially before the age of eight years. The author discusses the relative advantages of partial or total occlusion of the fixing eye in accordance with the usually accepted methods.

Chas. A. Bahn.

Van Manen, J. G. **Exophthalmic ophthalmoplegia.** Ophthalmologica **122**:207-214, Oct., 1951.

A case of presumably thyrotropic exophthalmos in a 31-year-old Chinese responded well to a series of X-ray treatments directed at the pituitary gland. The experimental and some of the clinical literature on endocrine exophthalmos is reviewed. Peter C. Kronfeld.

7

CONJUNCTIVA, CORNEA, SCLERA

Bocci, G. **Acquired antibacterial immunity of the conjunctival sac.** Boll. d'ocul. **30**:563-569, Sept., 1951.

Rabbits that weighed between 1,300 and 1,500 grams were given conjunctival instillations of antistaphylococcus vaccine, antistreptococcus vaccine, antipneumococcus vaccine, and staphylococcus anatoxine. Two weeks later, cultures of these organisms were instilled into the conjunctival sac of these treated rabbits and of control eyes. Marked inflammation was

produced in the control eyes while the immunized eyes remained free of symptoms. Further experiments showed that, in addition to the local immunity, a general immunity could be produced at later stages. K. W. Ascher.

Boros, B. **Allergic reaction of the conjunctiva during treatment with placental extract.** Klin. Monatsbl. f. Augenh. **119**: 510-513, 1951.

Boros has used placental extract according to Filatow in several hundred cases and in only two patients were there complications. A man, 60 years old, was given placental extract because of hemorrhage and clouding of the vitreous and a small, painful nodule developed in the conjunctiva at the site of injection. A 15-year-old boy was given the injections for parenchymatous keratitis. A large, flat infiltration was seen under the conjunctiva and was very painful. Boros believes these lesions to be an allergic reaction to the placental extract, due, not to protein, nor to any histamine substance, but to some lipoids of unknown character in the extract which bring about an allergic-hyperergic tissue proliferation. When hyperemia and a small nodule are seen at the site of injection, subcutaneous instead of subconjunctival injection should be used. (3 figures) B. T. Haessler.

Duc, Camillo. **Conjunctivitis from salmonella.** Rassegna ital. d'ottal. **20**:230-232, July-Aug., 1951.

A 48-year-old man complained of burning, lacrymation, sensation as of a foreign body in the eye and pain of 5 days duration. There was a mild hyperemia, a soft membrane adherent to the tarsal conjunctiva, small, partly confluent infiltrations at the corneal margin and tenderness and swelling of the pre-auricular glands. Culture showed short, rod-like, Gram-negative, rounded extracellular organisms. Serological test confirmed the diagnosis of salmonella infection. Mild local antiseptics produced a prompt cure.

Eugene M. Blake.

Fujii, Seitaro. **Cytological study of phlyctenular keratoconjunctivitis.** Acta Soc. Ophth. Japan **56**:30-41, Jan., 1952.

The author examined material expressed from phlyctenules, 21 of which were idiopathic and 15 of which occurred in eyes with phlyctenules caused by conjunctivitis, such as Koch-Weeks'. In the idiopathic phlyctenules, epithelioid and giant-cells were most often found. No such cells were demonstrable in secondary phlyctenules where polymorphonuclear leucocytes were found to predominate. Koch-Weeks' and Morax-Axenfeld bacilli were found in pure culture in some cases. The so-called round cell which occurs in idiopathic phlyctenules has been regarded as a lymphocyte, but the author believes to have demonstrated by means of vital and ultravital staining that most of these cells are not lymphocytes but monocytes.

Yukihiko Mitsui.

Garzino, Alessandro. **A rare case of vernal conjunctivitis with associated marginal degeneration of the cornea.** Rassegna ital. d'ottal. **20**:239-248, July-Aug., 1951.

A 35-year-old woman had had vernal catarrh for 15 years, with gradual increase of signs and symptoms. For several years, there had been an invasion of the corneal margins, first as small white spots which later became exuberant granulations. These occupied but a portion of the circumference, the remainder showed an epithelium-covered groove, central to which there was an infiltration of the corneal stroma. There were no eosinophiles in smear or histologic section. Poor general health and dwelling at high elevation were considered possible causes.

Cortisone had little effect except to reduce the itching. (4 figures, 35 references)

Eugene M. Blake.

Latte, B., and Pino, G. **Experimental infection of the conjunctiva with Newcastle virus.** Boll. d'ocul. **30**:553-562, Sept., 1951.

One doctor and four students volunteered for inoculation with the virus of Newcastle disease. Acute follicular conjunctivitis was accompanied by mild systemic symptoms, and there was leucopenia with relative lymphocytosis. The appearance of specific antibodies was inconstant. During the first three days of the conjunctival disease, the Newcastle virus could be isolated from the conjunctiva. Inclusion bodies could not be found. Reinoculation was followed by a new, milder conjunctivitis. The incubation period varied between 12 and 24 hours. Treatment with aureomycin was ineffectual. (3 tables, references)

K. W. Ascher.

Leibiger. **A case of progressive sclero-perikeratitis.** Klin. Monatsbl. f. Augenh. **119**:629-635, 1951.

The patient, a 60-year-old woman, had been under treatment for over a year when first seen by Leibiger. At this time the right eye had normal vision and was externally normal except for a pterigium-like mass and a radial clouding of the lens in the left eye. The cornea was cloudy and new-formed vessels entered the parenchyma from all sides, and covered the iris; lens and iris were adherent. The eyeball was soft, very painful and the vision questionable. The eye was enucleated and examined histologically.

Three months later the remaining eye became inflamed and painful and within six months had progressed to almost complete blindness. The findings in general resembled those that had been present in the left eye. The clinical picture was that of a progressive sclero-perikeratitis. A history of tuberculosis was obtained and chest X ray showed this to be inactive. A tuberculous process in the eye was postulated and this was confirmed by histologic examination of the enucleated eye. Tubercle bacili were demonstrated in the granulation tissue by means of midnightblue-carmine staining. Leibiger believes that this proves the tuberculous etiology of this disease. (2 figures, 36 references)

B. T. Haessler.

Löhlein, H. **Observations on a corneal aqueous vein and the question of its origin.** Klin. Monatsbl. f. Augenh. **119**:618-629, 1951.

After a perforating injury, an abscess of the cornea developed into a fistula in the 11-o'clock position; the anterior chamber collapsed, the intraocular pressure fell, the pupil was displaced and anterior synechias were present A corneal transplant was done to close the fistula. The intraocular pressure rose and could be brought to normal only fleetingly after repeated cyclodiathermy puncture and iridectomy. Examination of the patient six years after injury and three years after keratoplasty, showed peripheral vascularization of the cornea with marked changes at the lower edge of the trepanation. A wide superficial vein which arose in the deep central layers of the cornea coursed to the limbus, turned at the right edge toward 6 o'clock and, at the conjunctival scar tissue, connected with other episcleral vessels. The vein was shown to carry aqueous, not blood serum, and resembled that described by Weekers (Acta ophth. 29, 1951). The cases had in common 1. a vascularized leucoma of the entire cornea following severe intraocular inflammation, 2. increased ocular tension, and 3. no visible typical aqueous veins. Löhlein disagrees with Weekers that the aqueous veins

arise out of Schlemm's canal and suggests that a direct connection between the anterior chamber and the cornea must be postulated. (3 figures, 10 references)

B. T. Haessler.

Martius, Gerhard. **Prophylaxis of gonococcal conjunctivitis with penicillin oil.** Klin. Monatsbl. f. Augenh. **119**:611-616, 1951.

This preparation, manufactured by Winzer in Constance, contains 1,000 Oxford units of penicillin per gram, so that one drop contains approximately 35 units. The penicillin is in solution in the oil, not merely in suspension, and in this form has many advantages over the aqueous solution. It is less irritating than silver nitrate and certainly equally effective. It does not deteriorate rapidly and can therefore be used in private practice. Martius would like to see penicillin treatment legally replace the Credé treatment. (22 references)

B. T. Haessler.

Spadavecchia, V. **Systematisation of neurogenic corneal affections.** Boll. d'ocul. **30**:611-638, 1951.

An attempt is made to bring order into the confusing multiplicity of corneal lesions of neurogenic background. Clinically the author distinguishes punctate, miliary, disciform, ringlike, nummular, bandlike, nodular, central or paracentral, peripheral, and diffuse types; superficial and deep types are to be distinguished, and gradation and overlapping may be found necessary in some cases. Most widely distributed are the massive forms such as those observed after Gasserian ganglion destruction and (if included at all) keratomalacia. The changes observed may be infiltrative, edematous, vesicular, dystrophic, dendritic, sclerosing, filamentous, striate, plexiform or reticular. Here again, combinations and transitions will be encountered. Irritative and paralytic lesions must be considered and neuropathologic and vascularised and avascular forms exist. Pathologically, inflammatory, degenerative, and dystrophic types are found; the course of the disease can be transient, rapid, slow, intermittent, chronic or recurrent. Mild, medium, and severe cases may occur. For all these types examples from the literature are given. The lesions may be spontaneous or provoked and the primary seat of the lesion may be in the brain nuclei, in the nerve stem, or in the periphery. The author is aware of the inconveniences of his complicated scheme but he stresses the fact that only by such a classification can the kaleidoscopic variety of corneal neurodegenerative disease be clarified and treatment improved.

K. W. Ascher.

Spadavecchia, Vitangelo. **The nervous regulation of the cornea.** Ann. di ottal. e clin. ocul. **77**:353-358, Sept., 1951.

The innervation of the cornea is derived from both the autonomic nervous system and the trigeminal nerve, but functionally this twofold innervation is single and indivisible. The normal functioning of the cornea depends not only on centrifugal neurovegetative impulses but also on antidromic trigeminal impulses which may arise either centrally or reflexly.

Harry K. Messenger.

Straub, W. **The pathogenesis of keratoglobus.** Ophthalmologica **122**:239-244, Oct., 1951.

The term keratoglobus applies to corneas with normal base diameter but much greater than normal curvature. Such an anomaly developed in a 13-year-old girl as the immediate result of a blunt injury, caused by a blow from a cow's tail. Most of the cornea became severely edematous and much more acutely curved and prominent than normally. The existence of a traumatic tear of Descemet's membrane was assumed but could not be proved on account of the marked cloudi-

ness of the cornea. Under conservative treatment the condition subsided slowly.

Peter C. Kronfeld.

8

UVEA, SYMPATHETIC DISEASE, AQUEOUS

Birkbeck, M. Q., Buckler, W. St. J., Mason, R. M., and Tegner, W. S. **Iritis as the presenting symptom in ankylosing spondylitis.** Lancet **2**:802-803, Nov. 3, 1951.

Eleven cases of ankylosing spondylitis had an iritis as the chief symptom. The iritis was nonspecific and allergic in character. The authors suggest that all patients with nonspecific iritis should be investigated for a coexisting spondylitis and treated as early as possible.

Irwin E. Gaynon.

Brauch, Fritz. **Iridocyclitis after infection with leptospira.** Med. Klin. **46**:1105-1106, Oct. 19, 1951.

Iridocyclitis can occur as a late complication of a generalized infection with leptospira canicola. Peasants and butchers frequently are exposed to the disease. The case reported is that of a farmer who developed signs of meningitis and whose serologic and spinal fluid tests proved infection with canicola two weeks after the onset of the disease. There was complete recovery, but five months later an iridocyclitis occurred, possibly on the basis of an allergy to the infection, as neither the blood nor the spinal fluid showed any signs of inflammation.

Max Hirschfelder.

Focosi, M. **Iridocyclitis accompanying Hodgkin's disease and treated with a naphthylamin derivative.** Boll. d'ocul. **30**: 521-529, Sept., 1951.

A 46-year-old woman who had Hodgkin's disease developed a unilateral acute iridocyclitis with posterior corneal precipitates and vitreous opacities but no synechia. Naphthyl-bis-betachloroamin was administered in 200 to 300 mgm. doses daily until a total dose of 10 grams was reached. Recovery was complete. There was probably localization of the lymphogranulomatous change in the iris and ciliary body. (18 references)

K. W. Ascher.

Gilbert, W. **Ophthalmia lenta as a malignant leptospirosis of the eye.** Klin. Monatsbl. f. Augenh. **119**:607-610, 1951.

Some men still seem to believe that this recurrent iridocyclitis is caused by tuberculosis but it is certain that there is no such relationship. Pyodermia and ulcerations of the genitals must be present if a diagnosis of ophthalmia lenta is to be valid. Behçet's idea that a virus is the causative agent is no longer tenable. The close resemblance of ophthalmia lenta to the "moonblindness" of horses, which is known to be due to leptospirosis, makes Leptospira a probable causative agent. Ophthalmia lenta is a severe, progressive disease with involvement of the synovial membranes, the meninges and the liver. It drags on for many years and in most cases leads to complete blindness. Some ophthalmologists believe that there is a "benign" form as well as the severe form known as Weil's disease (and conditions closely related to it). Gilbert maintains that no such distinction is valid. In his opinion, ophthalmia lenta should be considered a leptospirosis which runs a malignant course. He has seen two cases in which agglutination to Leptospira was positive. In several others the serum reaction was negative, but these patients had been sick for a long time, with eye lesions present for 8 to 10 years.

Salvarsan, penicillin and other biotics have been therapeutically ineffectual. Successful treatment with aureomycin and terramycin has been reported but cannot be considered reliable. Gilbert has used Leptospira serum in three cases; in

two ciliary injection was temporarily completely cleared, in the third there was a local reaction of the uvea, possibly a focal infection, possibly a Herxheimer reaction, which cleared in 12 to 15 hours. (4 references) B. T. Haessler.

Niedermeier, Siegfried. **Experimental investigation of choroidal detachment.** Klin. Monatsbl. f. Augenh. 119:542-545, 1951.

Experiments on a series of albino rabbits confirm the work of Fronimopoulos in 1942 and show the correctness of Custodis' explanation of choroidal detachment. Niedermeier made permanent fistulas in the anterior segment. Through vital staining with methylene blue and Evans blue the author believes to have proved that choroidal detachment results from an increased permeability of the blood vessel wall, which is most marked in the iris. B. T. Haessler.

Pau, Hans. **Clinical and bacteriologic findings in ophthalmia lenta.** Klin. Monatsbl. f. Augenh. 119:480-486, 1951.

The syndrome of ophthalmia lenta consists of purulent uveitis, polydermia, fever, stomatitis, ulceration of the scrotum or vulva and swelling of the joints. The disease is most common in previously healthy men, 30 to 40 years of age. The attacks occur at intervals of four weeks to several months and visual acuity falls with each attack, leading finally to blindness. Yellow exudates are seen in the eyeground and the vessels become very thin. Pau reports two cases. In the first, the fundus resembled that seen in gliosis of the retina, with hazy white papilla and thin yellowish-white strands which are the remnants of vessels. In the second case there were numerous grayish-yellow exudates in the retina which covered the vessels; these disappeared within days or weeks and were followed by other inflammatory manifestations. With only slight clouding of the anterior chamber, the patient became blind over night, the fundus appeared gray and edematous and there were hemorrhagic streaks into the retina, which resembled thrombosis of the central vessels. Hypopyon developed the following day, but gradually receded so that the fundus was again visible a month later. The vessels were now obliterated. This case is described in detail because Pau believes he was able to isolate the causative organism. Puncture of the anterior chamber showed leucocytes with intra- and extracellular diplococci, some encapsulated, some, when extracellular, rod-like in form. An anaerobic diplococcus was grown in liver bouillon and a similar organism isolated from ulcers in the mouth, but the strain died after two or three recultures. Pau thinks this may be the same organism as that described by Behçet and considered by him to be an elementary virus. Whether these anaerobic diplococci are the true cause of ophthalmia lenta cannot yet be stated with assurance. The antibiotics are more apt to cause flareup than cure, and should be given, if at all, in very small doses. (2 figures) B. T. Haessler.

Rama, Giovanni. **A rare form of benign endothelial tumor of the anterior uveal tract.** Ann. di ottal. e clin. ocul. 77:373-382, Sept., 1951.

The tumor occurred in the left eye of a 67-year-old man. It originated in the outermost layers of the peripheral zone of the choroid and had made its way along the suprachoroidal space and through the sclerocorneal trabecula into the anterior chamber. The tumor overlay a congenital melanotic area of the iris, and Rama thinks that both this area and the tumor may be traceable to a single developmental anomaly.

Harry K. Messenger.

Wagner, Friederich. **Persistent pupillary membrane.** Klin. Monatsbl. f. Augenh. **119**:580-585, 1951.

In 1925 Pagenstecher described the occurrence of extensive persistence of the fetal pupillary membrane in three generations. Wagner now describes a similar occurrence in the fourth generation. The child had loss of vision about one month before she came to the clinic. A membrane arose on the surface of the iris, slightly peripheral to the pupillary margin. Peripherally it resembled the iris stroma, but centrally it was pale gray and transparent. It coalesced throughout with the lens capsule and anteriorly appeared as a thickening of the capsule, grayish-white and cloudy. Between its origin and the ring-like insertion at the capsule, there were cryptic defects of the membrane so that the flow of aqueous from the posterior into the anterior chamber was possible. The edge of the round, free pupil was visible through the peripheral part of the membrane. Both lenses showed diffuse subcapsular clouding and the fundus, though not clearly visible, seemed free of gross changes. Discission of the cataract caused the membrane, which was firmly adherent to the lens capsule, to tear. The lens was resorbed without complications, and vision, with cataract lenses, was 5/20.

Wagner discusses other, similar cases of persistent pupillary membrane and agrees with Rieger that these membranes probably arise from the pupillary membrane and are due to a developmental defect which arises after the seventh fetal month. The reason for the clouding of the lens is less clear. In the child described and in the mother, the lens opacity developed suddenly and progressed rapidly, therefore a disturbance of nutrition, due to the pupillary membrane present since birth, cannot adequately explain the condition. Perhaps mechanical factors, such as pulling of the membrane on the lens capsule during activity of the pupil, play an inciting role. (2 figures, 4 references)

B. T. Haessler.

9

GLAUCOMA AND OCULAR TENSION

Báró, I. **Hereditary glaucoma.** Ophthalmologica **122**:228-238, Oct., 1951.

Among 126 cases of primary glaucoma in adults, the author found 16 in which the hereditary nature of the disease was made highly probable by occurrence of at least one other case of the same type of glaucoma in the immediate family. The mode of transmission was dominant in seven and recessive in nine individuals.

Peter C. Kronfeld.

François, Jules. **Oculo-cutaneous angiomatosis (Lawford).** Ophthalmologica **122**:215-227, Oct., 1951.

The 13-year-old girl showed a large nevus flammeus of the right side of the face, dilation, tortuosity and varicosity of some of the epibulbar vessels and a chronic glaucoma, of the adult type, that is, without enlargement of the globe, in the right eye. This syndrome was first described by Lawford (Tr. Ophth. Soc. U. Kingdom 5:136, 1885). Gonioscopy revealed no angle abnormality. The glaucoma was attributed to an angiomatosis of the choroid. The ocular tension was normalized by an iridencleisis during which a small loss of vitreous occurred. The operation was followed by a retinal detachment which subsided without surgical treatment despite the presence of a retinal tear. Peter C. Kronfeld.

Grant, W. Morton. **Clinical tonography.** Tr. Am. Acad. Ophth. pp. 774-781, Nov.-Dec., 1951.

In the normal eye the tension will decrease if the tonometer is left on the eye

for more than one or two minutes. In glaucoma, especially of the open angle type, the tonometric pressure will probably remain stationary or increase if the instrument rests on the eye for the same time. With massage or pressure the aqueous outflow is normally increased. Tonography is a recent and accurate application of the massage principle to determine diminished aqueous outflow. Because of greater accuracy and ease of manipulation the author prefers the electronic tonometer to the Schiøtz model. The observation period used was four minutes. Results were not altered by normal variations of scleral rigidity. Based upon the study of 142 normal and 132 untreated glaucomatous eyes, the author concludes that clinical tonography should be a more widely used test for the accurate interpretation of glaucoma especially of the wide angle type. Chas. A. Bahn.

Weekers, R. **The corneal rigidity in cases of glaucoma without ocular hypertension.** Ophthalmologica **122**:187-189, Sept., 1951.

Each of the three cardinal symptoms of glaucoma, ocular hypertension visual field defects and cupping of the nerve head, may occur alone, not associated with and therefore independent of the other two cardinal symptoms (incomplete glaucomas according to Weekers). "The existence of glaucoma without hypertension has been proved by the observation of some cases over long periods, permitting repeated tonometries. It has actually been demonstrated that the glaucomatous scotomas and the excavation of the nerve head can develop in the complete absence of pathologic hypertension, even in its mild or transient form. We consider a glaucoma to be without hypertension if the ocular tension, in the course of prolonged observation, does not exceed the figure of 25 mm. Hg, Schiøtz. Some of our cases of glaucoma without hypertension have, for a number of years, maintained tensions below 22 mm. Hg, Schiøtz. The study of the diurnal variations in these cases has not revealed the slightest disturbance of the ocular tension."

To these observations, reported previously, Weekers now adds that the ocular rigidity, determined by tonometry with different loads, has been found to be normal in his cases of glaucoma without hypertension. Peter C. Kronfeld.

11

RETINA AND VITREOUS

Bruna, F. **A rare form of tapetoretinal macular degeneration.** Boll. d'ocul. **30**: 596-610, Oct., 1951.

An elliptic, sharply outlined, elevated grayish-pink area was found in the right macula of a ten-year-old boy and in his 46-year-old aunt; the patients belonged to a family of 14 members, 13 of whom were examined by the author. The left eyes of the boy and the aunt had normal visual acuity and almost normal fundus findings. The boy's father and two uncles showed bilateral macular degeneration, type Stargardt; one uncle could not be seen; the youngest aunt and her two children had normal eyes, and so did the five siblings of the affected boy. (2 figures, one in color, 32 references)

K. W. Ascher.

Fischer, Franz. **Albuminuric retinitis.** Med. Klin. **46**:980-982, Sept. 14, 1951.

The author describes the clinical findings of albuminuric retinopathy and discusses the edema of the optic disc, the degenerative exudates, hemorrhages and changes in the vessels. He states that these findings are always an expression of an irreversible chronic diffuse glomerulonephritis. Malignant nephrosclerosis, eclampsia and retinitis pseudoalbuminurica

may resemble this condition. The various theories of pathogenesis are mentioned.

Max Hirschfelder.

Forsius, Henrik. **Fundus changes in constitutional thrombopathy (Willebrand-Jürgen's disease).** Acta ophth. **29**:347-353, 1951.

Constitutional thrombopathy is a familial hemorrhagic diathesis, which affects both sexes. While on a hematological expedition to Aland Islands in Finland, the author examined 26 eyes in four separate families which had this disease. Four of them had retinal hemorrhages; they were small, situated in the nerve fiber layer, and quickly resorbed.

Ray K. Daily.

Gát, L., and Mándi, L. **Tuberculous papilloretinitis.** Ophthalmologica **122**:143-153, Sept., 1951.

The occurrence of an apparently characteristic papilloretinitis in tuberculous individuals was reported by Gát in 1949 (Am. J. Ophth. 32:879, 1949). The incidence of this condition was studied further and found to be closely related to phases of high cutaneous sensitivity, that is allergy, to tuberculin. The papilloretinitis should therefore be regarded as a manifestation of a specific allergy and not as a toxic phenomenon.

Peter C. Kronfeld.

Kyrieleis, Werner. **Ophthalmoscopic diagnosis of general vascular disease.** Deutsche med. Wchnschr. **76**:1436-1439, Nov. 16, 1951; and 1493-1496, Nov. 23, 1951.

The author stresses the importance of fundus examination as part of every medical examination. In organic vascular disease there are arteriosclerotic changes with widened reflexes and thickening of the arterial wall. Closure of the central artery and thrombosis of the central retinal vein are usually caused by arteriosclerosis. The obliteration of vessels in thromboangiitis and periphlebitis are the result of organic vascular disease. The term "angiospasm" is often used inaccurately in describing functional vascular retinal changes.. True spasms are found in quinine poisoning, disturbances of the menopause and in eclampsia. The latter brings about circumscribed and changeable contractions and, unlike malignant nephrosclerosis, does not necessarily lead to permanent damage. Like Volhard and Thiel, Krieleis distinguishes sharply between "white" and "red" hypertension. Only the "white" (pale) hypertension results in a typical ophthalmoscopic picture with narrowing of the arteries and the arteriovenous crossing phenomenon of Gunn. Hemorrhages and exudates are secondary disturbances in the region of the endarteries which are enhanced whenever the renal function is impaired. There are no typical vascular changes in red hypertension; however, it may develop into the more serious picture of white hypertension. A table arranges the various characteristic change of the retinal arteries and veins in such a way as to facilitate diagnosis for the general practitioner. (5 figures, 1 table)

Max Hirschfelder.

Palich-Szántó, Olga. **Phlebektasia fundi.** Ophthalmologica **122**:81-86, Aug., 1951.

The term phlebektasia fundi is applied to a unilateral widening of the retinal veins in the more ametropic eye of a 35-year-old man. The condition is thought to be a congenital anomaly.

Peter C. Kronfeld.

Panepinto, V., and Leone, S. **Sunlight as a factor determining seasonal variations in the incidence of idiopathic detachment of the retina: significance of**

the statistical correlation between detachment and insolation. Ann. di ottal. e clin. ocul. 77:493-500, Dec., 1951.

Idiopathic retinal detachment, of which 160 cases were studied by the authors in Palermo was most frequent in May and least in October and December. This frequency distribution is found by modern methods of analysis to be statistically significant, and agrees with Weeker's observation of the seasonal incidence of idiopathic detachment. Of the various possible meteorologic factors, insolation, that is, the number of hours per day during which the sun is above the horizon, is most important. In persons predisposed to detachment the prolonged action of sunlight is a contributory factor because of its photochemical, mechanical, or metabolic effect on the retina. (References)

Harry K. Messenger.

Parker, Francis W. **Ambulatory treatment of retinal vascular disease.** Illinois M.J. 100:358-361, Dec., 1951.

Dicumarol is a vasodilator, causes a hypoprothrombinemia, restores the repellent force of the red blood cells and decreases agglutination and adhesiveness of blood platelets. It prevents thrombus formation and thrombus propagation. Vitamin P increases capillary fragility. Vitamin C maintains a normal state of the intercellular cement. Twenty-three patients with retinal vascular disease received dicumarol for from 5 to 30 months and in 14 of them the retinal lesions have not advanced. All these patients had some form of hypertensive disease. Six patients with diabetes were not benefited by treatment with dicumarol. The prothrombus concentration percentage must be determined repeatedly before treatment with dicumarol is begun and during this time the patient must be in the hospital, but after the individual dosage is known ambulatory treatment is satisfactory. Heparin is used to initiate the treatment of vascular occlusion. (22 references)

Irwin E. Gaynon.

Ramm, Hans. **Re-Pla-Serol in retinitis pigmentosa.** Klin. Monatsbl. f. Augenh. 119:513-516, 1951.

The treatment of retinitis pigmentosa entered a new phase when Filatow introduced subconjunctival implantation of pieces of fresh placenta. In this operation, a sterile piece of placenta is implanted under the conjunctiva, lateral to the cornea; both eyes are operated upon on the same day and the operation may be repeated at intervals if indicated. Placenta contains numerous hormones, vitamins, ferments and other substances; it is known that follicular hormone dilates vessels experimentally, corpus luteum hormone weakens the action of atropine on the pupil, vitamin A heightens dark adaptation and vitamin E acts on the neuromuscular system. All these substances are contained in fresh placenta. Re-Pla-Serol is an ointment, made by Merz in Frankfort, which retains the active elements in unchanged form. Ten patients were treated with this preparation; eight eyes had first been operated upon according to Filatow and were then given inunctions of the ointment twice daily into the conjunctiva; two patients received the ointment only. One man, who was practically blind, was not benefited by the treatment, nor was he harmed. In all the others, night vision as well as general visual acuity were improved, and the visual field was widened. However, no change could be seen in the eyeground. Ramm concludes that Re-Pla-Serol alone gives as good results as placental implantation and should be given serious consideration in the treatment of retinitis pigmentosa. B. T. Haessler.

Rosengren, Bengt. **Observations in a case of retinal rupture without detachment.** Acta ophth. 29:291-294, 1951.

A man, 47 years of age, who had a spot in the upper visual field of the right eye was found to have an extensive rupture behind the equator with very slight elevation of the retina. The retinal vessels passed over the rupture, and the anterior retinal layers were intact. There was an elevation over the anterior margin of the rupture where the intact surface layer of the retina was displaced toward the vitreous. An examination of the left eye showed similar retinal changes suggestive of deep ruptures in the lower temporal quadrant. Both eyes were successfully treated by diathermy with a small electrode. (2 figures) Ray K. Daily.

Rudolph, C. J., and Sirlin, E. **Retrolental fibroplasia and anoxia.** J. Indiana St. M.A. **44**:1161-1163, Dec., 1951.

In retrolental fibroplasia there is a liquefaction of the protoplasmic substances of the vascular wall, with transudate of plasma and, later, diapedesis of the red cells, dilatation of the vessel walls and degenerative contraction of the vitreous scars. The lens is pushed forward and the anterior chamber becomes shallow. Finally there is microphthalmus. Among the predisposing factors, the anoxia of prematurity is probably the most important. (2 colored plates)

Irwin E. Gaynon.

Trovati, Emma. **Tortuosity of the retinal veins, as related to diseases of the brain.** Ann. di ottal. e clin. occul. **77**:366-372, Sept., 1951.

Trovati reports a case of bilateral papilledema and marked tortuosity of the retinal veins in a person who presumably had a brain tumor. Various types of venous tortuosity are mentioned, and the differential diagnosis is discussed, with particular reference to angiomatosis of the retina. (References)

Harry K. Messenger.

Vrabec, F. **Histologic findings in a case of congenital pigmentary degeneration of the retina.** Ophthalmologica **122**:65-75, Aug., 1951.

A 26-year-old man, amaurotic since birth, requested enucleation of one eye on account of pain due to a posttraumatic iridocyclitis. The eyegrounds could not be seen because of extensive corneal scars after phlyctenular keratitis. Enucleation of the injured eye gave the patient so much relief that he insisted on the removal of the other, practically uninflamed eye. The histologic examinations revealed the picture of pigmentary degeneration in the periphery of both eyes. The findings at the posterior pole were remarkable. Over an area markedly exceeding the normal limits of the macula the visual cell layer consisted only of somewhat underdeveloped cones. There were no findings suggestive of disappearance of the rods through a degenerative process. The layout of the fovea and of the papilla suggested arrest of development at a critical stage. The author classifies the case as belonging between the stationary and the progressive tapetoretinal degenerations.

Peter C. Kronfeld.

De Vries, S. **Retinal hemorrhages in posterior vitreous detachment.** Ophthalmologica **122**:245-248, Oct., 1951.

In five patients the onset of a typical spontaneous posterior vitreous detachment was accompanied by minute retinal hemorrhages, presumably a sign of the "microtrauma" put upon the retina by the sudden pulling-away of the vitreous.

Peter C. Kronfeld.

12

OPTIC NERVE AND CHIASM

Štajduhar, J. **The etiology of pseudoglaucoma.** Ophthalmologica **122**:129-142, Sept., 1951.

Two cases of optic atrophy, with marked glaucoma-like excavations but without elevation or instability of the ocular tension, are reported in detail. The intracranial pressure measured by cisternal puncture was low in one and within normal limits in the second case. The author stresses the many weaknesses of Klar's hypothesis that intracranial hypotony can give rise to glaucoma-like states in the presence of normal ocular tension. Peter C. Kronfeld.

13

NEURO-OPHTHALMOLOGY

Cucco, Giovanni. **Ocular manifestations in the syndrome of subarachnoid hemorrhage.** Ann. di ottal. e clin. ocul. **77**:454-463, Nov., 1951.

Insufficient notice has been taken hitherto of the ocular manifestations in spontaneous subarachnoid hemorrhage. Retinal hemorrhages have been commonly noted, but Cucco calls particular attention to the importance of subconjunctival hemorrhages and conjunctival phlebectasias. These vascular manifestations in the eye appear for the most part to arise independently of mechanical factors; they are not "symptomatic" or secondary but should be interpreted as primary evidence of the same vascular lability that is responsible for the subarachnoid hemorrhage. The conjunctival vessels are analogous to those of the pia mater in lacking any supporting tissue that can offer resistance, and so are readily subject to dilatation and extravasation (References) Harry K. Messenger.

Montresor, Dante. **Foster Kennedy's syndrome in Paget's disease of the skull.** Ann. di ottal. e clin. ocul. **77**:343-352, Sept., 1951.

Montresor reports a case of a 69-year-old man with osteitis deformans, marked optic atrophy in the right and papilledema in the left eye. These were caused by narrowing of the optic foramina which was roentgenologically demonstrated. In order to forestall optic atrophy in the left eye trepanation of the superior wall of the left optic canal is suggested. (References) Harry K. Messenger.)

15

EYELIDS, LACRIMAL APPARATUS

Huggert, A. **A probable case of primary tuberculosis of the lacrimal sac.** Acta ophth. **29**:339-346, 1951.

A five-year-old girl developed tuberculous dacryocystitis, probably primary, after a brief exposure to infection. She recovered promptly under streptomycin therapy, and was successfully operated upon one year later by the Toti-Kuhnt technique. The excised portion of the lacrimal sac gave no evidence of tuberculosis on microscopic examination and a culture from a gland in the neck remained sterile. Ray K. Daily.

Markovitch, A. **The divisions of the lacrimal apparatus.** Ann. d'ocul. **184**:803-810, Sept., 1951.

The classification of the lacrimal apparatus and its diseases now in general use is incomplete and inadequate. This division consists of two parts: secretory (glandular), and excretory; it omits the intermediate portion which is clinically, pathologically and etiologically the most important because it serves as a reservoir for the conjunctiva and the tears. Markovitch gives a brief description of the physical and chemical protective functions of the tears, and emphasizes the importance of the third or intermediate unit. In many forms of functional lacrimation and in acute and chronic diseases such as trachoma and pemphigus, this intermediate portion is of great importance.

Chas. A. Bahn.

NEWS ITEMS

Edited by Donald J. Lyle, M.D.
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News items should reach the editor by the 12th of the month but, to receive adequate publicity, notices of postgraduate courses, meetings, and so forth should be received at least three months before the date of occurrence.

Deaths

Dr. Louis Lehrfeld, Philadelphia, Pennsylvania, died February 6, 1952, aged 62 years.

Dr. Karl Ludwig Stoll, Cincinnati, Ohio, died December 17, 1951, aged 76 years.

Dr. Melchiore Lombardo, Brooklyn, New York, died February 10, 1952, aged 76 years.

Announcements

Midwestern research meeting

The fourth annual meeting of the Midwestern Section of the Association for Research in Ophthalmology was held at the Indiana University Medical Center, Indianapolis, Indiana, on April 5, 1952, at 9:00 A.M. The Midwestern Section encompasses the states of Minnesota, Wisconsin, Illinois, Indiana, Iowa, Nebraska, Kansas, and Missouri.

Orthoptic examinations

The annual examination of orthoptic technicians by the American Orthoptic Council will be conducted in September and October, 1952.

The written examination will be nonassembled and will be on Thursday, September 4, in certain assigned cities, and will be proctored by designated ophthalmologists.

The oral and practical examinations will be on Saturday, October 11th, in Chicago, just preceding the meeting of the American Academy of Ophthalmology and Otolaryngology.

Application for examination will be received by the office of the secretary of the American Orthoptic Council, Dr. Frank D. Costenbader, 1605 22nd Street, N.W., Washington 8, D.C., and must be accompanied by the examination fee of $30.00. Applications will not be accepted after July 1, 1952.

Home study courses

The 1952-1953 Home Study courses in the basic sciences related to ophthalmology and otolaryngology, offered as a part of the educational program of the American Academy of Ophthalmology and Otolaryngology, will begin on September 1, 1952, and continue for a period of 10 months. Detailed information and application forms can be obtained from Dr. William L. Benedict, executive secretary-treasurer of the academy, 100 First Avenue Building, Rochester, Minnesota. Registrations should be completed before August 15, 1952.

Residencies in ophthalmology

Residencies in ophthalmology are available immediately at the City of Detroit Receiving Hospital for physicians who have completed training in basic ophthalmology. This large municipal hospital for emergency cases and indigent patients needs additional residents to staff an eight story addition and offers opportunity for clinical and surgical training, as well as research in ophthalmology, with the facilities and staff of the Kresge Eye Institute available. Graduate training is offered in optics, biochemistry, ocular pathology, and motility. Tax-free grants are offered until residents are eligible for the city payroll. For information write Dr. Albert D. Ruedemann, Kresge Eye Institute, 690 Mullett Street, Detroit 26, Michigan.

Research fellowships

Information regarding research fellowships in ophthalmology at Indiana University Medical Center may be obtained by writing to Dr. T. F. Schlaegel, Jr., 1040 West Michigan Street, Indianapolis 7, Indiana. It is not necessary to have had training in ophthalmology to be accepted for these positions. For those who have not had a graduate course in ophthalmology, these research fellowships will provide some training prior to a residency. The fellows assist in the eye clinic and at eye surgery and attend the formal classes for eye residents. The stipend is $150.00 per month plus room and laundry.

Pan-American Proceedings

The *Proceedings* of the IV Pan-American Congress of Ophthalmology, recently held at Mexico City, will be ready for distribution early in June. There will be three volumes of about 500 pages each, and most of the material will be published in English. The cost will be $20.00 in United States currency. All inquiries should be addressed to Dr. Luis Sanchez Bulnes, Gomez Farias 19, Mexico, D.F., Mexico.

Oxford Ophthalmological Congress

The Oxford Ophthalmological Congress will convene at Balliol College, Broad Street, Oxford, on the evening of July 2nd and meetings will be held on July 3rd, 4th, and 5th. The Doyne Memorial Lecture will be presented by Dr. Dorothy Campbell, Conventry, on Friday morning. Dr. Campbell's subject will be "Ophthalmic stress."

On Thursday morning, July 3rd, there will be a discussion on "The long term results of treatment of concomitant convergent strabismus in terms of binocular function," and on Saturday morning the

discussion will be on "Recent trends in ocular therapeutics."

Among the speakers at this congress will be: Dr. Bernard Samuels, New York; Professor Bietti, Italy; Thomson Henderson, Nottingham; F. A. Williamson Noble, James Doggart, O. Gayer Morgan, N. H. L. Ridley, and D. Harley, all of London.

Miscellaneous

Speak at Yale

On February 8th, Dr. Abraham Schlossman, New York, guest speaker at the Yale University School of Medicine Postgraduate Course in Ophthalmology, discussed "The practical aspects of orthoptics." He stressed that orthoptics might be practiced by the ophthalmologist in his own office without the assistance of a trained technician. Dr. Schlossman and Miss Dorothy Parkhill, orthoptic technician at The New York Eye and Ear Infirmary, then answered questions and comments from the floor.

Dr. Clement C. Clarke commented briefly on his concepts of amblyopia as noted at the New Haven Hospital strabismus clinic. Dr. Frederick Wies brought up the question of why the amblyopic eye could often be brought to 20/30 vision but no better. He also cited several examples of "late" cases of strabismus that responded to occlusion. Dr. Alexander Van Heuven commented on the European schools, some of which consider orthoptics most important while others strongly oppose such treatment.

The meeting was preceded by a clinical case of a nine-year-old boy with concomitant strabismus, who postoperatively demonstrated a large anomalous retinal correspondence with monocular diplopia (binocular triplopia). Miss Rachel Petrini, orthoptic technician, demonstrated with the patient how normal correspondence was established by concentrating on the dim image (the good soldier).

Prevention of blindness conference

More than 500 prevention of blindess workers from all parts of the United States, Canada, and other countries met at the Mellon Institute in Pittsburgh, March 19th to 21st for the 43rd conference of the National Society for the Prevention of Blindness.

Dr. Edmond R. McCluskey, professor of pediatrics, University of Pittsburgh School of Medicine, was chairman, Wednesday morning, of the discussion on children's eye problems, which included such topics as correction of muscle imbalance, detecting and correcting visual defects among preschool children, and environmental factors in visual efficiency.

On Wednesday afternoon, under the chairmanship of Dr. Conrad Berens of New York, reports were heard on the present status of corticotropin (ACTH) and cortisone, survey of vision loss in New York state due to retrolental fibroplasia, management of congenital glaucoma, hereditary eye conditions, and relationship of clinical research and fundamental research.

Thursday morning the conference was concerned with sight conservation in industry. The chairman was Dr. J. Huber Wagner of the United States Steel Corporation, Pittsburgh. In the afternoon on Thursday there were separate group discussions for teachers, nurses, and social workers.

Friday morning's program dealt with eye problems of middle age.

Societies

Reading meeting

Dr. Howard T. Karsner, medical research advisor to the Bureau of Medicine and Surgery, Department of the Navy, Washington, D.C., was guest speaker at the eighth annual joint meeting of the Diplomates Association of Berke County Physicians and the Reading (Pennsylvania) Eye, Ear, Nose, and Throat Society. He spoke on "Modern directions of medical investigation," paying particular attention to atomic radiation.

Newly elected officers of the Diplomates Association are: president, Dr. William P. Jennings, Reading; president-elect, Dr. John B. Levan, Reading; secretary, Dr. James E. Landis, Reading.

Organization meeting

At the organization meeting of the Southeastern Pennsylvania Chapter of the American College of Surgeons, the following officers were elected: president, Dr. William L. Estes, Jr., Bethlehem; vice-president, Dr. Frank G. Runyeon, Reading; secretary, Dr. Irvin G. Shaffer, Reading. Dr. Paul C. Craig, Reading, was the organizing secretary.

Personals

Dr. Hermann M. Burian, formerly of Boston, joined the staff of the Department of Ophthalmology, College of Medicine, State University of Iowa, Iowa City, Iowa, on September 1, 1951, as an associate professor.

Dr. Irving H. Leopold has been appointed an attending surgeon at the Wills Eye Hospital, Philadelphia, succeeding to the service of the late Dr. Louis Lehrfeld, who died on February 6, 1952.

Dr. Lehrfeld had served the Wills Eye Hospital over a period of 36 years until his death.

The 15th annual deSchweinitz Lecture will be given on Thursday, November 20, 1952, by Dr. Francis Heed Adler of Philadelphia. His subject will be "The pathologic physiology of strabismus."

The annual award of the Committee on Industrial Ophthalmology of the American Academy of Ophthalmology and Otolaryngology was presented to Capt. Charles W. Shilling (MC) U.S.N. in recognition of outstanding leadership and service to scientific research.

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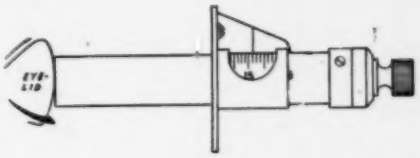

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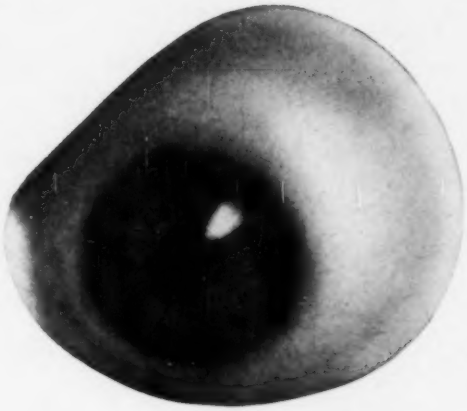

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